HYDROBIOLOGICAL STUDIES OF KEERAT SAGAR POND IN MAHOBA DISTRICT

Thesis

Submitted for the Degree of Doctor of Philosophy
In Zoology

Bundelkhand University, Jhansi (India)

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CERTIFICATE

This is to certify that the work entitled **"Hydrobiological Studies of Keerat Sagar pond in Mahoba District"** is a piece of researchwork done by manoj Gupta under my guidance and supervision for the degree of Doctor of Philosophy in Zoology of Bundelkhand University, Jhansi (U.P.), India. The Candidate has put in an attendance of more than 200 days with me.

To the best of my knowledge and belief the thesis :

(i) embodies the work of the candidate himself ;

(ii) has duly been completed ;

(iii) fulfils the requirement of the ordinance relating to the Ph.D. degree of the University ;

(iv) is upto the standard both in respect of contents and language for being referred to the examiner.

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DECLARATION

I, hereby declare that the thesis entitled **"Hydrobiological Studies of Keerat Sagar Pond in Mahoba District"** is an original piece of research work done by me under the guidance and supervision of DR. K.V. Singh Deptt. of Zoology, Pt. J.N.P.G. College, Banda.

This is submitted to the Bundelkhand University, Jhansi, Uttar Pradesh in fulfilment of the requirement for the award of the degree of Doctor of Philosophy in Zoology.

I consulted the libraries of Sagar University, Sagar, Jiwaji University, Gwalior, J.N.U., Delhi University and N.I.S.C.I.R. New Delhi for the research papers and Journals. I also participated in UGC National Seminar in which I presented my research paper "Domestic Sewage wastes Management In Rivers of Banda (U.P.)".

I further declare that the thesis or a part of it has not been previously submitted for the award of any degree.

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Place : Banda

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INTRODUCTION

INTRODUCTION

India is a principal agricultūral subcontinent with suitable climatic conditions for the production of various crops. Besides, it is very rich in aquatic resources i.e. rivers, lakes, ponds, tanks, reservoirs etc. which are very essential for the irrigation hence much production of the various crops is being done. The lentic aquatic bodies of various types cover an area viz. 2.09 million ha. of reservoirs; 2.25 million ha. of ponds and tanks and 1.46 million ha. of lakes and swamps. Hence about 73% of the earth is covered with marine and fresh water.

Further the total water resources of the world amounts to 26.6 trilliont, approx. 94.7% of this huge volume of water occurs in the lithosphere. Its major part being bound to minerals which constitute the rockbed. This is known as bound water. These waters have been forming a part of the structure of minerals and get released only at high temprature.

The water has been one of the most important strategic natural resources for mankind through out the history. However, the world's water resources are under pressure and contamination risks due to overuse and misuse of these resources. people strive to sustain their lives under in appropriate environmental conditions. But the streams are the clean water resources among all water resources. As the clean water resources are more prone to pollution. In developing countries such as Turkey, 95 % of the used water is not purified before they are released to surface water. As a result much water pollution occurs.

Since the quality of water affects our lives in many ways, water must be of good quality for healthy survival of organisms. As the water contains the dissolval

and suspended constituents in varying proportions, which affects its chemical and physical properties. For this chemical methods are applied to measure the concentration of pollutants. About 35,000 infants die in the world every day due to diseases caused by vitiated environment. The carrying capacity of the environment is unlimited and more important. Some areas or ecosystems are more suscepti ble to adverse environmental impacts than others.

Water is required in various domestic purposes, irrigation, shipping sanitation power generation, industries, fish production, prawn and pearl culture etc. out of the total global water only 3 % is suitable fresh water for human life. Whenever water is put to beneficial uses, only a part it is consumed and the rest comes out as waste water. Man's in fluence on the quality of waste water is quite apparent and is now a major economic and political concern.

Broadly limnology can be stated as a scientific study of physical chemical and biological conditions of a fresh water. How ever Wetzel (1975) defined the term limnology as "the study of functional realtionship and productivity of fresh water biotic environmental parameters".Among the pioneers in the field of limnology, the earliest known work is that of F.A. forel (1841-1912). At present the limnology has become an important field in scientific in vestigations.

The perview of limnology the International association of theoretical and applied Limnology in 1922, included lotic and lentic water system. The lentic water system consists of ponds, tanks, lakes, dams and reservoirs.

However, the term pond has such universal use, and the general conception of a pond is so widely understood, that it seems best to employ the term pond for

that class of very small, shallow bodies of standing water in which relatively quiet water and extensive plant occupancy are common characteristics. Ponds are mainly of three general classes: (i) those which represent the pond stage in the extinct of previously existing lakes. (ii) those whose basins have never been large or deep (not preceded by a lake) but instead have been small of area from the start and, because of recent origin or for some special reason, have persisted in the pond stage; and (iii) Those whose basins are the results of men's activities. Natural processes alone are constantly forming new pond basins (cut-offs from streams, solution basins, beach ponds, and many others), some of which are never more than temporary ponds from the beginning; others as permanent ponds at least for a period in their existence. with respect to seasonal duration, ponds are customarily divided into two general classes : (i) temporary-those in which the basin Contains water at certaintimes or seasons (ii) Permanent-those which contain some water around the year.

The ponds, reservoirs, and lakes are the main fresh water sources in our country, and in order to avoid disasters in the form of eutrophication firmly steps should be taken. Hence it is important to study the physico-chemical characteristics of water. The most important physico-chemical characteristics of water are: temperature, turbidity, total dissolved solids, counductivity hardness, hydrogen-Ion-concentration, carbon-di-oxide. alkalinity, Dissolved oxygen, chloride, phosphate, nitrogen etc.

That the great diversity of lakes is also represented in ponds, goes without saying, since not only are the conditions of origin, distribution, and general status similar, but also ponds are of ten them selves the evolutionary successors of

previously existing lakes. In most respects, limnological knowledge of lakes is much more advanced than that of ponds; infact, for ponds it is fragmentary, often altogether lacking in some aspects, and widely scattered in the literature. Much has been learned about fish ponds of various kinds; about open, water supply reservoirs. However is both instances, man's influence is usually a potent modifying factor; and while many of the facts worked out in these more or less arfificial situations are applicable in an understanding of pond life (nevertheless, these waters can not quality natural, unmodified ponds).

Reservoirs, the important fresh water resources have the potential to substantially augment the inland fish production of the country. The large potential of the resource for fish production remains underexoploited due to paucity of data on ecology and fishery potential and improper management, measurement of primary production. Photosynthesis is helpful to understand the trophic status and to assess the fish production potential of aquatic ecosystem (melack, 1976; Mcconnel et . al.,1988; Oglesby, 1977), productivity of a number of reservoirs have been determined (Sreernivasan, 1970; Pathak, 1979; Kannan and Job, 1980).

The literature available on reservoir fisheries mainly centered around production potentials. (Paul and Sagunan, 1990). The ecological changes in physico-chemical, phytoplankton and zooplankton aspects are due to the industrial and demestic discharges. Most Indian reservoirs cxhibit low primary production attributable to high complex interaction of pollutants descharged into the reservoir (konar et al., 1991). Our knowledge of impact of harmful industrial and municipal effluents is grossly inadequate (Sugunan,1995).

A low-lying part of the Earth's surface which contains rain water and its water flow out from river is called a lake. There are various kinds of lakes on Earth i.e. freshwater lakes and salt water lakes, ranging in size from small fish pond to vast water bodies such as superior lake of USA that is known as the largest fresh water lake of the world, on other hand there are two precious example of salt water lakes, the caspian in Europe and sambhar in Rajasthan. India also has numorous lakes spread all over the country from Kashmir to Kerala and Rajasthan to Assam. Dal lake in srinagar and the Nainital lake is popular. whether natural or manmade lakes are major sources of water. These lakes are homes to a large variety of aquatic life with some exception; As in Israel there is a salt water lake, which does not have any kind of life because it has too much salt in its water due to which life could not be sustained.

The changes in physical parameter of natural water are used as the direct and the indirect indices of water. But the physical parameters only are not absolute indices of water pollution as their normal values may very considerably depending on various chemical characteristics of the water due to the run-off. The biological inventory depends largely on the season, but it presents a vary reliable picture of the average situation since the community of organisms and plants can not adopt itself rapidly to sudden changes. e.g.a dairy released waste water and its biological investigation would show the level of pollution.

Sewage waste is the result of urbanisation and is mostly discharged into water bodies. which increases pollution. The sewage waste which include human-excreta, detergent, garbage, west paper, clothes, kitchen washings etc. The organic matter is the main cause of pollution of water bodies. Which promotes the growth of various micro-organisms especially various pathogenic bacteria and

viruses which occur in the water at the points of sewage disposal (Tiwari et. al. 1991). They multiply rapidly and contaminate the water which cause epidemic diseases like cholera, Typhoid, dysenetry, etc. Besides, it contains amoeba, eggs and larvae of nematodes and worms which are gastrointestinal parasites in humanbeings and water contaminated with them causes jaundice amoebiasis and various other diseases. Further decom position of organic wastes by bacteria and fungi result in severe depletion in the level of dissolved oxygen in water which may be harmful to the aquatic plants and animals specially fishes. various gases are evolved as bye-products during the process of decomposition of organic matter eg, H_2S, CH_4 etc. Which give an unpleasant taste and odour to the water and making it unfit for use. The pollution of the sewage waste is measured in the terms of Biochemical oxygen demand (B.O.D.). Discharge of untreated sewage to the water bodies threatens the water sources and makes them unfit for human as well as cattles use either for drinking or bathing.

For the last two to three decades several investigators have studied the hydrobiological profiles of varied lentic bodies with the intent of assessing the quality of the water (Shastri and Pendse, 2001; Singh 2000; Azizul Islam, 2001).But in Comparision to reverine ecosystem lentic water bodies, particularary have not been explored enough and only sporadic account of their physico-chemical and biodiversity status is available so far (Hazarica and Datta. 1998). A persual of literature on the lentic water bodies in the Indian subcontinent indicates deterioration of water quality in general (Chandrasekhar and Jafar, 1998).

The important climatic factor that determines the productivity of the lakes and ponds is the latitudinal location , which determines the Quantum of solar energy available for photosynthetic aitivities. The prevailing atmospheric

temperature also plays an important role in the thermal and nutrient regimes, wind is yet another important meteorological factor that helps in mixing up water and transportation of nutrients. However very high wind velocity has an adverse affect on plankton and fish catching. In the present study, it was noticed that on the day when the wind velocity was very high, the catch was low, (Chaudhary, 1978) has also reported that a heavy wind flow made fishing difficult in Ranapratap sagar.

The edaphic factors include the physico-chemical and biological factors which are mostly positivity co-related with the production. Among these conductivity or T.D.S. is the important factor which helps in the fish production. since electrical conductivity reflects the total dissolved solids, it gives a reliable indication of the edaphic quality of water. Thus the edaphic factors like total alkalinity (Ball,1948, Cardander,1955), total hardness (Barrelt, 1953) and total dissolved solids (Northcot and larkin, 1956; Rawson, 1951) are Co-related with fish production viz plankton, bottom biota etc.

Soil also plays an important role in determining the fertilify of fish ponds. The basis criterion for selection of a site for construction of ponds is that the soil should not be porous. A knowledge of different types of soils of India is helpful in understanding the problems related to the retentivity of water by the soil and productivity of ponds, lakes and other water bodies located in different regions of the country.

The soils of India are classified under 8 major heads : (i) alluvial (ii) black (regur); (iii) red; (iv) laterite; (v) forest; (vi) desert; (vii) saline alkaline; and (Viii) Peat.

Alluvial soil covers an area of about 1,500,000 Square km in the Indo-gangetic plain, punjab, Gujarat, orissa, Tamil Nadu, Kerla, etc, and is formed by silt

deposited by numberous river system. Black soil is found in Maharashtra, western part of Madhya Pradesh, parts of Tamilnadu, black soil is highly impevious to water and becômes sticky when wet. It possesses a high capacity of conservation of soil moisture. In Allregur areas, in general, and particularly in those derived form ferromagnesian schists, the soil contains a layer of kankar nodules formed by segregation of calcium carbonate at some depth below the surface and above the weathered rock. The soils contain a high quantity of montmorillonitic and beidellitic group of minerals. The red soil area extends into santhal parganas, the Birbhum district of west Bengal, Mirzapur, and Bündelkhand region.

The fertility of water bodies soil refers to its nutrient releasing properties for the benefit of aquatic flora as well as fish productivity. Soil fertility relates to four stages: (i) The nutrient requirements by aquatic flora and their release from soil (ii) the status of silt as a store house of nutrients (iii) The way nutrients are leached from the soil (iv) The methods permitting to maintain or restore soil fertility. In the case of aquatic flora, the nutrients are directly required by micro and macro-vegetation and certain bacteria also that may grow in fishery waters. At present not much is known about the direct or indirect relationship of soil with fish production of various plant nutrients present in the soil, nitrogen, phosphate and potassium very often become deficient and are to be supplemented from out side. Ramamoorthy and Bajaj (1969) have prepared the soil fertility map of India. The map may also help in deciding suitable fertilizer mixtures for different regions taking into account the actual amounts of nitrogen, phosphorus and potassium available in the soil and in planning the production distribution and consumption of various fertilizers in different parts of the country.

The fertilizers used in fish ponds fall under two categories (i) inorganic, and (ii) organic. The inorganic fertilizer contains the major fertilizing elements which are nitrogen phosphorus, potassium and calcium. minor elements having a manurial value are manganese, boron, sulphur, iron, copper, and zinc. Inorganic fertilizers can be prepared with precise amounts of desired elements as they have a definite and constant chemical composition of nutrient elements. The soluble inorganic fertilizers make their elements available to the water immediately which are applied. The inorganic fertilizers are customarily expressed as percentage of available nitrogen, phosphorus and potash. The different inorganic fertilizers used in fish ponds are grouped as: (a) limestone and lime containing fertilizers; (b) phosphate fertilizers; (c) nitrogenous fertilizers, (d) potassium fertilizers; (e) magnesium fertilizers; and trace element fertilizers. The organic manures, as a class, are composite and contain almost all the nutrient elements reguired in the metabolic cycle. They enrich the organic matter content of soil and water and, within the limits of manurial dose, release carbon-di-oxide and nutrients on decomposition, sustaining the fertility of water. Several kinds of useful bacteria may also get incidentally introduced along with the organic fertilizers into the ecosystem. The use of organic manures in a fishery water, already having thick organic sediment at the bottom, hastens the depletion of dissolved oxygen and enhances production of toxic gases. Therefore it is necessary to examine the pond for the application of optimum dose.

So the various fresh water bodies are managed for the fish production The fishes are used as the substitute of the food in the form of proteinous diet. Hence, it fulfills the scarcity of the food. For the high production of fishes the different lentic water bodies are scientifically managed so that their physico-chemical characteriastics of the water and soil conditions might be made suitable for the

high productivity of fishes. As regards this various measures are done. It was also suggested that in tropics special attention should be given to the ponds which could bė used as fish farms. In the above concern the International Biological programmes (I.B.P. news No.I and 2.1964 and 1965).

Having in View the utilisation of water bodies for much more production of fishes.The government has established various fisheries department. Besides, private agencies are also engaged in this feild. They are managing scientifically some of the fresh water bodies in the forms of various fish farms. These fish farms mainly produce fry and fingerlings artifically by induced breeding and supply them as seed to deffrent fish farms. Some of these agencies have hatcheries and others are doing production of fishes. Therefore a lot of efforts are to be made in this feild of fish production. Though a very few fresh water bodies are being properly managed for the good production of fishes. Hence a lot of fresh water resources which are lying unmanaged they are still to be managed scientifically for much more production of fishes which might be used to meet out the food problem.

For the productivity of the fishes their habitat which are fresh water bodies their physico-chemical, biological and soil factors must be suitable for the fish biology.

Existance of a life is possible so long as the food is available in an ecosystem. Fishes and shrimps too depend on food from various niches within the water bodies, but all such food items are not inert. A wide spectrum of aquatic flora and fauna which are consumed by the fishes and shrimps for their growth and maintenance are worth to be studied in detail. According to location-distribution and size aquatic organisms are named differently eg:- plankton, Periphyton, benthos.

Always there is definite preferance, selection or discarding of a specific organism as a food item for the fishes. Moreover, physico-chemical factors and environment also influence the food organisms a lot by way of encouraging proliferation of a kind by suppressing others. Thus the variations and the distributional patterns of these fish food organisms make the aquatic system either productive or unproductive from fisheries point of view, depending on the relative representation on of beneficial and undesirable forms in the biotope. Therefore, the studies on fish food organisms also help in estimation of compatible and competitive ones for the manipulation of the biotic environment in favour of exploitation. However, a simple study about the scattering and abundance of fish food organisms in an aquatic system is incomplete unless the same is compared to the findings of food and feeding habit studies along with the knowledge about the index of preponderance for the fishes and shrimps.

The term 'plankton' was first of all used by Hensen in 1887, to designate the hetero genous assembalge of suspended microscopic materials, minute organisms and detritus in water (welch,1935). According to APHA (1985) the term 'plankton' refers to those microscopic aquatic organisms having little or no resistance to currents and live in a free floating and suspended state, in open waters. As regards this plankton are classified as phytoplankton and zooplankton. phytoplankton are capable of photosynthetic activities and zooplankton are dependent on the phytoplankton for their nurishment.

In fresh water, the plankton are generally small or microscopic in size, than salt water. Most of the organisms belonging to plankton community are small and vary in size. According to Barness (1982), no size based classification has been adopted universally but bacterial ultraplankton; 5-50 μ m , the largely algal

'nannoplankton; 50-500 μ m, the mocro plankton of algae and animals; 500-2003 μ m, the animal 'megaplankton'. For the convenience of qualitative and quantitive study, plankters can be divided into: (i-) Nanno plankton (Those that can not be filtered by standard size plankton net). (ii-) Net plankton (those that remain in filtrate during filtration.

Plankton, specially phytoplankton have been used as indicator of water quality. Several Indian and foreign limnologists have reported that destribution and composition of plankton population varies from lake to lake and pond to pond due to variation in their physico-chemical characteristics. Remarkable studies conducted by Indians in this field are by Ganapati (1943), Alikunti et al, (1955), George (1966), Sreernivasan (1970), Moitra and Mukherji (1972), Verma et al. (1978), Zafar (1986), Verma and munshi (1987), etc.

The influence of physico-chemical factors on the growth and development of plankton has been reported by several researchers (Pearsall, 1923, 1932; chandler, 1944; Patric, 1948; Rao, 1955; Datta et al. 1959. Reid 1961) on the basis of the enrichment bioassay experiment, Mahoney (1989) Suggested that nitrogen was the most important nutrient in the regulation of phytoplankton growth in north east united states coastal and shelf waters. According to him phosphorus was yet another essential nutrient which enhanced phytoplankton growth.

Photosynthesis is the fundamental process involved in primary production, mostly the organic matter of an aquatic ecosystem is produced within the water by phytoplankton which are utilized by the consumers. Extensive work has been done on the phytoplankton primary productivity of static water habitat of India (sreenivasan, 1963,64,76; vijayaraghvan 1971; Nasar and Dattamunshi, 1975; 1975;

Singh and Swarup, 1980; Datta et al. 1984; Ahmad and singh (1987) but for riverine systems it is fragmentary. Majority of workers have so for failed to make any comparative study between the pond and river ecosystem. The phytoplanktonic productivity varies from one water body to another one. Fu rther the same water body may also show different production in different years (Singh, 1995).

Topographically keerat sagar is a very important historical site. It is established by 13 th king Kirtiverman of Mahoba in 1060 B.C. It is situated on the west of Mahoba. which is 55 km away from Banda. The kirat tiraha is on eastern side named on it. Adjoinning to the embankment on the eastern side an monument of Alha memorial is situated. On this side there are Ghats on the embankment namely Mahila ghat, Purush ghat and Dhobi ghat. Besides the Sagar is used for various human activities. No. of trees are found on the embankment e. g.- Ficus bengalensis, Delbergia sessoo, Ficus religosa, Mangigera indica etc.

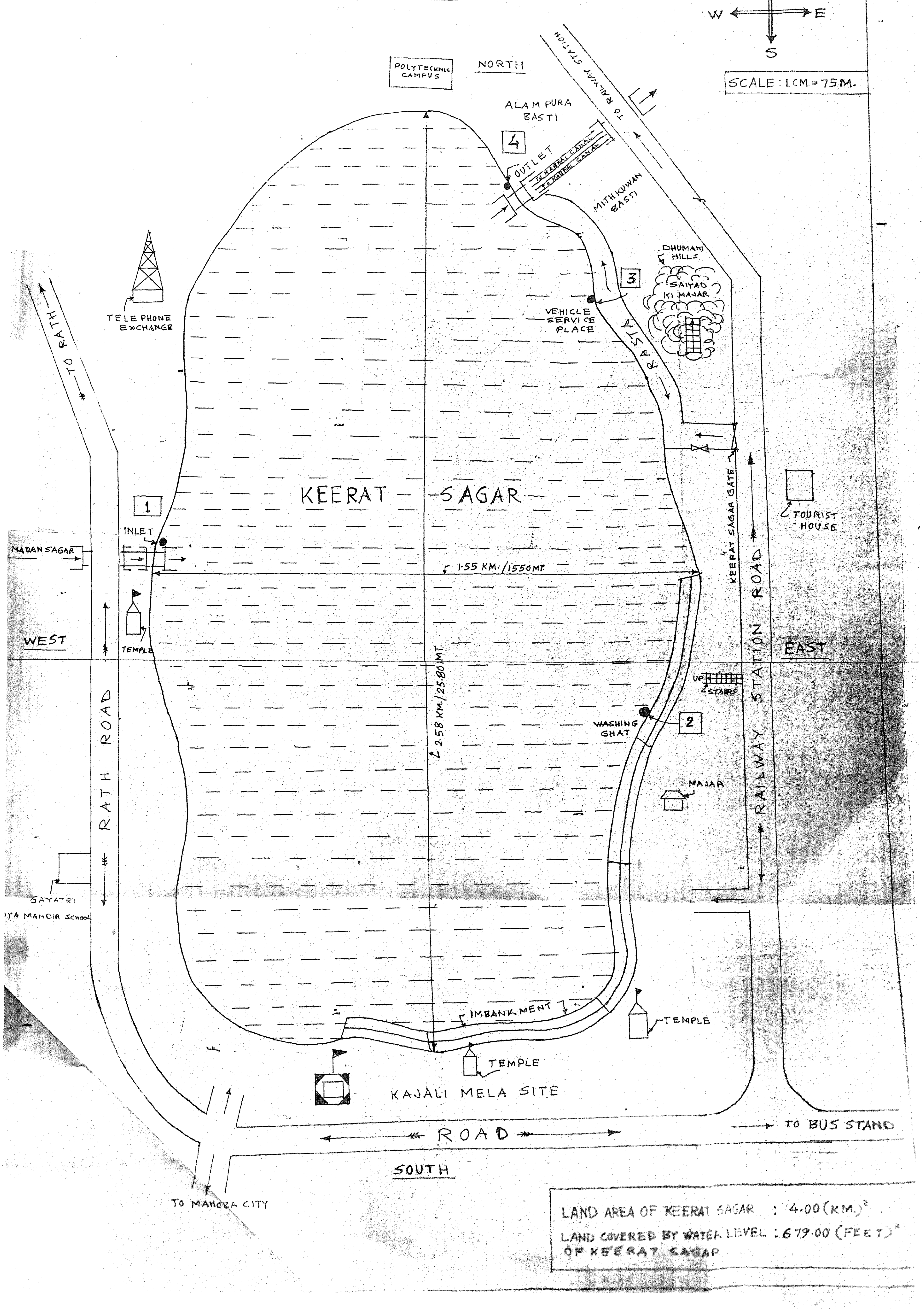
Four sampling stations were selected for the study-station I-Inlet which is situated on the southern side. It is fed by Madan sagar, Mukandlal G.I.C. is situated near the inlet. Station II-situated on the eastern side. On this station cultivation of water nut is done. People take bath along with washing activites. station III and IV-located on the northern side. Near station III Dhumni hill is situated, where vehicles are being whashed, and station IV- is outlet from where two canals have been dug out for irrigation. Adjacent to it a polytechnic college and there by Railway station. Para Kajali-mela the local festival is organised on keerat sagar on next day of Rakshabandan. It is celebrated in the memory of the victory of Alha-Udal and their warriers over the king Prithwiraj Chauhan who attacked on Mahoba on the day of Rakshabandhan. Due to it this festival could not be celebrated on that very day.

Keerat sagar is perennial which at present is not used for the fish production neither by the fishries department nor by private agencies though it is a very large water body which can be managed for high fish production. On its study it was observed that various measures are to be done i.e.-to make embankment on the three remaining sides, so that there might be no wastage of water and the storage capacity will increase which is essential for fish habitat, proper manuring and liming which will provide optium chemical characteristics of water. Besides, the soil will also receive, nutrients, to provide water productivity. Further removal of municipal wastes and check on it will provide the water safe. Hence, by doing the above measures this water body might be made for an ideal fish farm.

The aim of the proposed study of keerat sagar is to examine its hydrobio-logical factors and to suggest measures for much more fish production, so that it might be useful as an ideal fish farm, which might produce more protein rich food to solve the food problem. Besides, it will also provide a good revenue to the Government.

MAP OF KEERAT SAGAR AT MAHOBA CITY

(FIG. NO. 1)



REVIEW

OF

LITERATURE

REVIEW OF LITERATURE

An extensive work on hydrobiology has been carried out in foreign countries whereas in tropical countries particularly in India insuffícent work has been done in this field. Obiviously more attention is required to explore various remaining fresh water bodies, so that the food problem might be solved by utilising these water bodies properly for the fish production.

The various workers who have worked in this field their work are mentioned as under :

The earlier workers on the limnlogical studies are Birge and Juday (1912), Juday (1915-16) who investigated in detail the finger lakes of New York and certain lakes in central America respetively. Allen (1920) observed on the quantitative and statistical study of the plankton of Sanjoaquin river and its tributeries in and near Stockton while Griffith (1923) studied the phytotlankton of fresh water in relation to occurrence and composition. Butcher et al. (1930) observed variations in the composition of river waters. Atkin (1932-33) studied the chemistry of sea water in relation to the productivity of the sea. Juday et al. (1935) studied the carbon-di-oxide and hydrogen-ion-concentration of the lake water of North Eastern Wisconsin. Sewell (1935) studied the tropical and subtropical waters in certain areas. Ohle (1938) determined pH and alkalinity and co-related them with control of liming in ponds. Steiner (1938) showed that the inorganic phosphate which is liberated from dead plankton (animalcules) by the putrefactive activity of bacteria is set free in the water. Harvey (1940) reported nitrogen and phosphorus required for the growth of phyto plankton. Chandler (1940) Observed on the plankton and certain physico-chemical parameters on light entrance and its relation to turbidity, and in (1944) the relationship of the phyto-plankton to the limnological and climatic factors of Wistern lake of the Bass islands, as far as Hutchinson (1941) studied the mechanism of Intermediary metabolism of

stratified lakes. Chacko et. al. (1949) studied the hydro-biological conditions of Adyar river and found dissolved oxygen from nit to 6.02 mg /1. pH varied from 8.0 to 8.6, phosphate in the range of nil to 0.11 mg/1, chloride was recorded in the range of 40.2 to 2800. o mg/1 whereas no nitrate was found.

Patrick (1953) in the study of biological stages of stream pollution quoted that the controlled physico-chemical activities of aquatic life in surface waters are necessary for the maintenance of purified water conditions. The most direct measurement of this biodynamic cycle would indicate the exact condition of the water. Matsudaira and Kato (1953) observed the impurities in rain water in Oska and kobe cities. The comparative limnological study of eight lakes of Colorado mountain was made by Pennak (1955). Das and srivastava (1956) studied the fresh water plankton of fish tank in Lucknow. Dorai Rajan and Pankajam (1956) did significant work on the hydrology and plankton of Bhawani sagar reservoir in madras state. Smalll reservoirs of some east Europian countries have been similarly studied by Chalupa and Cervenka, (1958) ; Byars (1960) studied the physico-chemical factors and plankton of a fresh water pond in Newzealand. Rao (1961) carried out a systematic hydro-geological study in parts of Hoshangabad and Narsinghpur districts of Madhya Pradesh.

This revealed that the quality of water in the area was mildly alkaline but it was good for general use. Hazlwood and Parker (1961) studied the population dynamics of the fresh water zooplankton. The seasonal Variations of nitrate, phosphate and silicates in the waters of the English lake. The population dynamics of certain fresh water zooplankton was investigated in 1961 by Heron. In two shallow ponds of Delhi diurnal variations studied by George (1961-1962) the occurrence of permanent algal bloom in a fish tank at Delhi with special reference to factors responsible for its production. The first study on the plankton of the Tungbhadra reservoir was made by Govind (1963). The ecological role of

phosphorus in water with certain reference to micro-organisms examined by Phillips (1964). The observationson on the death of fish due to cold in the river Gandak was done by Jhingran el al in (1964). The plankton of macro-fauna and chemical constituents studies of water of a pond, and their bearing on fish production was made by Michael (1964). Imevbore (1967) studied the hydrology and plankton of Eleiyele, reservoir, Ibandon, Nigeria studies made by Bulusa et al. (1967). Jafer (1967) worked on ecology of algae in certain fish ponds of Hyderabad. Moitra and Bhowmik (1968) studied seasonal changes of Rotifers in fish pond in kalyanii west Bengal. Watanabe (1968) made observations or daily changes of temperature and dissolved- oxygen in a pond in the Suburbs of Tokyo. Population studies of pond zooplankton were made by Armitage and Smith (1968). Martine (1968) studied the seasonal changes in zooplankton excretion rates in relation to phyto-abundance. Whitford and Schumachar (1968) made observations on the ecology of some species of fresh water algae. Patalas and Patalas (1969) noticed that plankton abundance fluctuate with the Variation of electrolyte content of the water. A distinct relationship between plankton periodicity and rain fall was observed by Lind (1969). Singh (1970) worked on the limnology of Keetham lake. Nicola and Borgeson (1970) studied three lakes to determine relationship between the chemical and physical characteristics, primary production and zooplankton standing crop. Distribution of zooplankton complex due to diurnal vertical migration related to the horizontal movement of water layers was noticed by Chaoman (1970). The biological aspects and physico-chemical characteristics of kamla Nehru tank at muzaffar nagar (u.p.) were studied by Verma and Sukla (1970) and they noted that oxygen relationship the rise and fall of phosphate. They also recorded the inverse relationship between nitrate and temperature. Saha, et al (1971) investigated the seasonal and dirunal variation in physico-chemical and biological conditions of perennial fresh water pond at Cuttack. Mayer and Glossa (1980) studied the silica and phosphate in a turbid river. Ayyappan et. al. (1980) described seasonal changes in plankton population of fresh water ponds at Patna, Bihar (India).

Ramakrishnaih and Sarkar (1982). Studied limnological observation on Rihand reservoir. Singh et. al. (1982) studied plankton productivity in relation to certain hydrological factors in Konar resevoir (Bihar).

The limnological studies have been made by Compose et. al. (1982) of lake Ranco (Chile) with reference,. morphometry physico-chemical and plankton. Bhati and Rana (1982) reported zooplankton in relation to the abiotic components with reference to pollution in the Fort moat of Baratpur. Singh (1983) in vestigated the hydrobiology of a pond in Shahjahan garden, Agra. Stout (1985) studied the ecology of three small lakes near kaikoura, white Buergi et. al. (1986) investigated the seasonal variations in the tropic structure phytoplankton and zooplankton communities in lakes at different trophic levels.

Lakshmanan et. al. (1986) studied the quality of water supplied in and around the twincities of Hyderabad and Secunderabad with respect to pH, chloride, these perameters were found within the permissible limits for drinking water in surface water of this area. Singh (1987) studied the Limnology of the circuit house pond Agra. Dora et. al. (1987) investigated water quality of subernarekha in Bihar state and reported cu from 0.03 to 3.0 mg/1 and zn from 0.001 to 4.6 mg/1 due to disposal of waste water. The concentration of metallic elements are alarming due to the disposal of wastes from the complex. Limnology of a tropical pond with reference to fisheries has been in vestigated by singh (1990). He found that plankton population showed biomodel pattern of fluctuation with one peak in winter and other in summer, most of planktonic organism showed seasonal variation in density and period of occurrence. Singh et. al. (1991) investigated physico-chemical factors and phyto plankton of Pawapuri pond and observed that pH, dissolved oxygen, Alkalinity, chloride and phosphate depicited erratic seasonal fluctuations imparting profound impact on the phyto plankton.Patralekh (1991) studied phytoplankton periodicity in a perennial pond of Bhagalpur, India and

observed that phytoplankton population exhibited marked fluctuation in different seasons. Its maxium population was recorded in March and minimum was found in August.. Impact of fishing management in cladoceran population was studied by Prazakova (1991). During the two years cycle of fishery management. In the first year of cycle biomass of large cladocerans prevailed. The species Daphnia galiota was present in both the years. It was more numerous in the second year. Sarwar et. al. (1991) reported physico-chemical parameter of a fresh water pond of Shrinagar (Kashmir) in which temperature varied from 4.0°C to 24.0°C, pH was between 7.0 and 8.2 electrical conductivity between 297 and 689 us/cm. Dissolved oxygen in the range of 0.3 to 5.2 mg/1, magnesium between 92 and 375 mg/1, while chloride in range of 4.0 to 120 mg/1 and iron was found between 20 and 2080 mg/1. Thus, physico-chemical characteristics of investigated water body are indicative of its eutrophic nature.

Singh et al. (1991) studied the distribrtion of Fe, Zn, Cu, Ni, Pb, Cd, and Cr in skin and muscle of tropical marine fishes, and observed that metal contamination were high in skin tissues in comparison to muscle tissues. Noustaka et. al. (1992) studied phytoplanlton and physical-chemical features of Tavrops reservoir Greece. seasonal sequence of biomass showed three annual peaks. Diatoms crypto phytes, chrysophyte and dinoflagellates were the major constituents of reservoir phyto plankton. Inees 'O' Farrell (1993) studied the phyto planktdon ecology community structure dynamics and limnology of Salado river (Buneos Aires, Argentina). Ecological studies on the kerkini reservoir (Greece) was studied by Kamarianos et. al (1993) and observed that Cyanophyceae Chlorophyceae, Dinophyceae, Diatomeae Chrysophyceae in considerable seasonal variation in their abundance diversity and number comprised the phyto plankton population. The abundance of Rotifer and the presence of various copepodid stages through out the year were also characteristics.

Verma (1993) studied physico-chemical and biological parameters of Betwa river at mandideep and noted that temperature varied from 18^{0}C to 34^{0}C, pH from 6.4 to 7.9, turbidity between 10 and 330 NTU, nitrate from 0.1 to 9.1 mg/1, chloride between 11 and 780 mg/1, dissolved oxygen from nil to 80 mg/1, where nil was in the polluted zone of the river. BOD was in the range of 0.8 to 300 mg/1, COD varied from 10 to 510 mg/1, whereas total coliform fluctuated between 110 and 2400+/100 ml. These authors in (1993), investigated phytoplankton seasonal variations and their relations ship with physico-chemical properties in a hypereutrophic central Indian lake. Bose & Gorai (1993) observed seasonal fluctuation of plankton in relation to physico-chemical parameters of a fresh water tanks of Dhanbad India. Kaushite and sharma (1994) studied the physico-chemical characteristics and zooplankton population of a perennial tank, Matsya sarovar, Gwalior. Gupta et. al (1994) studied the seasonal variations in selected physico-chemical parameters in Amarchand reservoir, Rajasthan, based on depth wise study, the reservoir maintained fairly good levels of dissolved oxygen which varied from 4.0 to 26.80 ppm. The maximum oxygen levels were observed in the month of December. This might be due to better oxygen holding capacity of water at low temperature in winter. This has also been justified from the significant co-relationship between dissolved oxygen and water temperature. Singh (1995) studied physico-chemical and Biological analysis of river Ganga in Kanpur District. Verma et. al. (1995) studied physico-chemical characteristics of fresh water pond at Laxmisagar. The co-relation among different parameters were determined. Positive co-relation of pH was observed with chloride, dissolved-oxygen and conductivity. Negative co-relation of pH was observed with calcium, free carbon-di-oxide. Negative co-relation of temperature was observed with calcium. free carbon-di-oxide. Positive co-relation of temperature was observed with chloride and conductivity. Magnesium and dissolved oxygen showed positive co-relations with temperature. According to chairman central Board for prevention and control of water pollution India (CBPCWP) (1989) the industries of Bombay account for only 13 percent of the total wastes dumped into water bodies. In Delhi,

the yamuna takes in every day about 200 million litres of untreated human wastes while the in dustries account for only 20 million litres of effluents. The International Institute of applied systems analysis in Austria has warned that water pollution will be India's major problem in 25 years unless, sewerage and sanitation facilities are improved. It said the accumulated human wastes could mix with open water resources resulting in epidemics. Bais and Agrawal (1995) made the comparative study of the zooplanktonic spectrum in the sagar lake and military engineering lake. They identified that the Protozoa, Rotifera, Cladocera, Ostracopoda and Copepoda were the main groups in both the lakes. They also found that the main limiting factor which hampered the density of the zooplankton population in the military engineering lake sagar was a very low population of phytoplankton. Mwachiro et. al. (1997) investigated the heavy metal status of the reservoir Barinear Udaipur (Rajasthan and the accumulation of the metals in fish organs, and found that the concentration of heavy metals in the water of the resevoir and fish organs is high due to mining activity of udaipur basin. Seasonal variation in the abundance and composition of phytoplankton in the river Ganges at Narora, U.P. was studied by Khan, A.A., Alam, A and Gaur, R.K. (1998). The studies on phytoplankton communities and primary production in middle stretch of river Ganga in context of cultural eutrophication were done by khan, M.A., Panwan R.S., Mathur, A and Jetly Rekha (1998), Limnological parameters of a temple pond in Kerala were investigated by chandrasekhar, S.V.A. and Mohammed Jafar, P. (1998), Physico-chemical characteristies of a highly eutrophic temple tank Bikaner were worked out by Bahura, C.K. (1998) phytoplankton primary production and fish production potential of Nelligudda reservoir (Bangalore, South India) were studied by Krishna Rao, D.S. and Katre Shakuntala (1999). The ecology and fish potential of selected reservoirs of Karnataka reported by Rama Krishniah, M., D.S. Krishna Rao, P.K. (2000). Seasonal variation of zooplankton in a tropical lake was studied by Singh D.N. (2000). The limnological study of fish ponds in Rajshahi, Bangladesh was observed by Azizul Islam, M., Chowdhary, A.N. and Zaman, M. (2001). The water and soil characteristics of the Narmada estuary before

commencing of Sardar Sarovar dam were studied by Nath, D. (2001). Ecological status and production dynamics of stretch of river Mahanandi were analysed by Pathak, V. Mahavari, L.R. and Sarkar, A. (2001). The impact on physico-chemical characteristics of Ganga water due to city sewage discharge was worked by Mishra, B.P. and Tripathi, B.D. (2001). Limnological studies on river Ramganga at Bareilly were done by Habib, I. (2002) investigation on hydrobiological profile of Kolavoi lake, Chingelput district India was made by Bharathi, D. and Ramanibai, F. (2002). Hydrobiological studies on river Nakatia at Bareilly were done by Habib, I. (2004). Dubey et. al. (2004) studied the ecological restoration and sustainable development problems and perspective.

MATERIAL AND METHODS

MATERIAL AND METHODS

The various Parameters of physical chemical, and biological of water and soil in keerat sagar were studied as per the methods given in the book of 'standard methods for the examination of water and waste water (APHA 1985 18th Ed.) Besides, on the basis of morphometry directional location depth of water and the vegetations etc. Four experimenta*/l stations were selected for the present study. Which are: A.B.C and D .

STATION-A:

It's location is on the southern side and is fed by Madan sagar so it is the inlet, which is shallow. (Plate-1)

STATION-B:

It is located in the eastern side which is deep and bathing and washing ghats with many trees on its embakment (Plate-2).

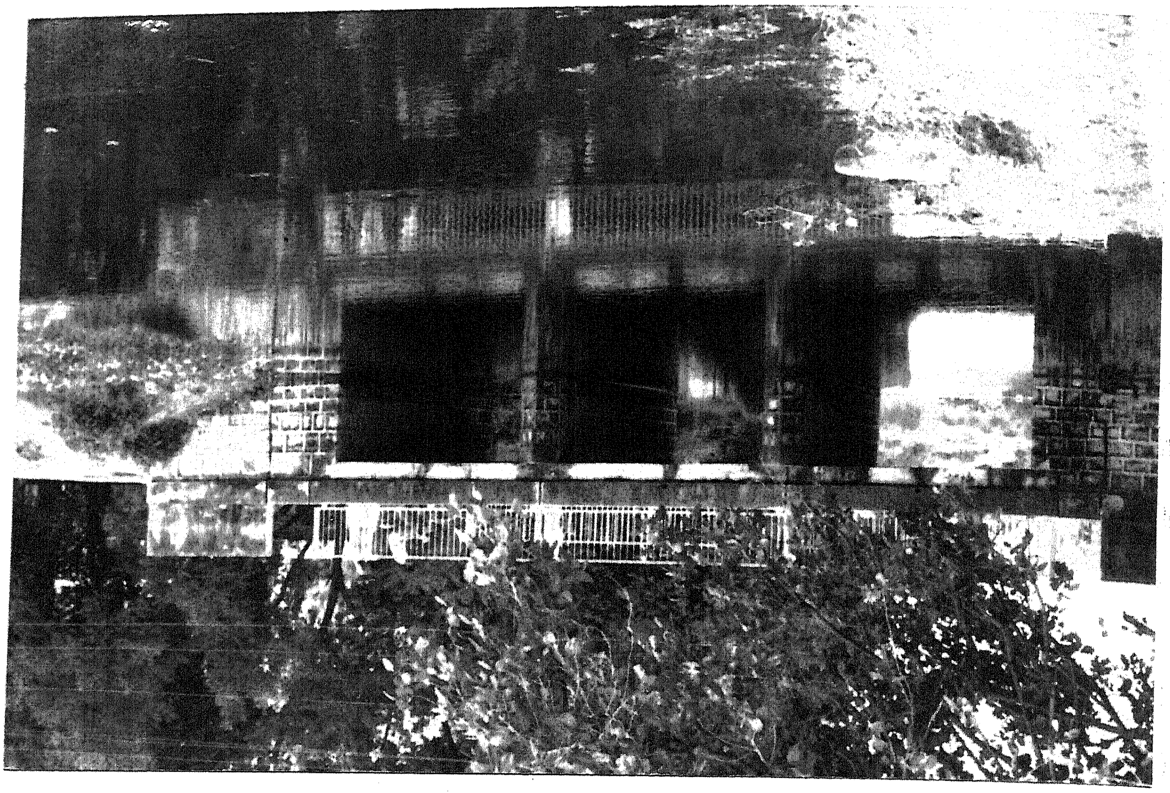
STATION-C:

It is located in the northern side which is deep with thin aquatic vegetation on its bank and is used for vehicles servicing ect. (plate-3)

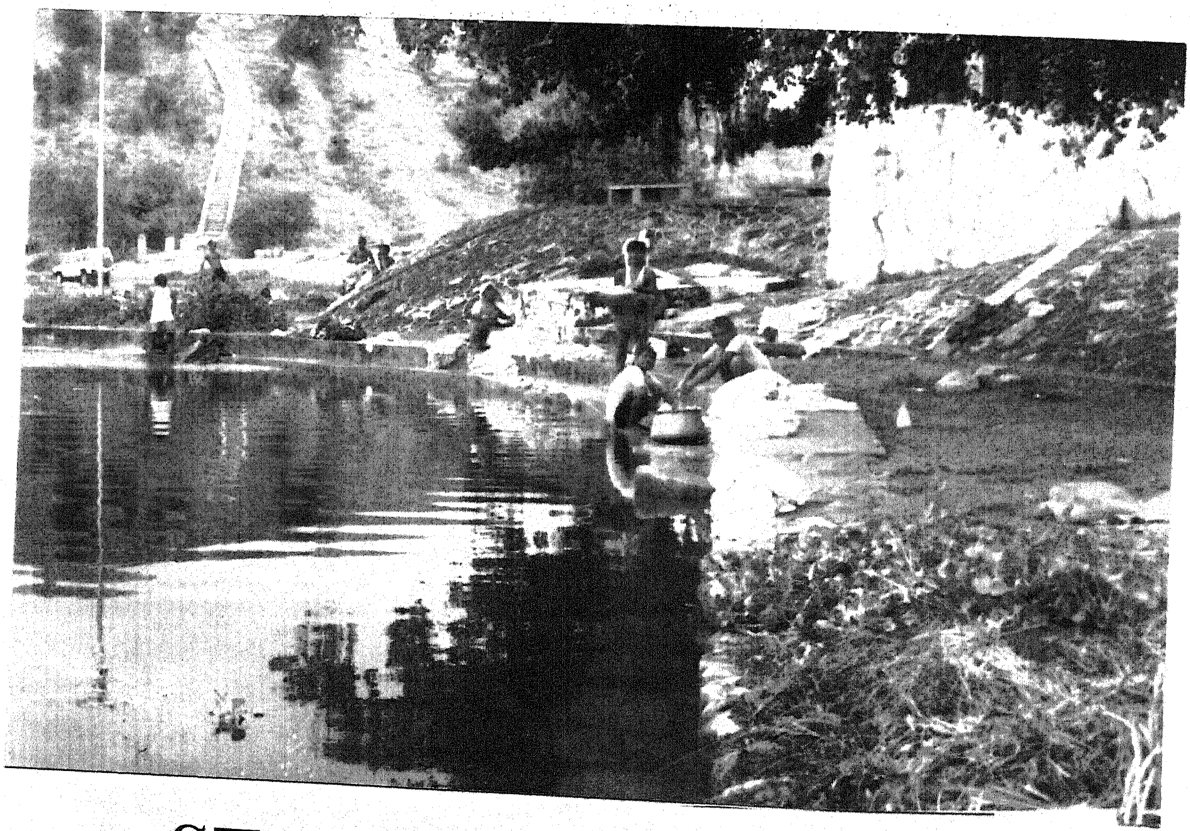
STATION-D:

It is located at the tail end in the northern side which is the out let from where two canals have been dug out for irrigation. (plate-4)

The westren side of the sagar is quite shallow without embankment obviously it has no definite range of water because it spreads on an indefinite area of surrounding open land in rainy season. Therefore there is no significance of selecting the sampling station on this side.



STATION-A (PLATE-1)



STATION-B (PLATE-2)

Water Sampling:

During the present investigation monthly water samples from all the four stations were taken from the sarface layers in fore noon with the help of water sampling bottles and plankton net. Physical parameter like temperature, water movement, colour, Depth were studied on the site where as Turbidity, Hydrogen-ion concentradion Dissolved oxygen, carbon-dioxide, Ammonical nitrogen. Phosphate, chloride, carbonate and bi-carbonate and planktons were estimated in the laboratory, for which the water samples were brought from the site in the laboratory for their chemical and biological analysis.

ANALYSIS TECHNIQUES:

Physical Parameters:

Temperature:

The temperature of water was recorded at the time of sampling by a murcury thermometer graduated up to accuracy of 0.5 ^{0}c. The measurement range was from ^{0}c. to 50 ^{0}c.

Colour:

The colour of water was observed by visual appearance only.

Turbidity:

Turbidity was recorded by a systronics Nephloturbidity meter and expressed as NTU.

Depth:

Depth was measured with the help of bamboos after marking.

Water movement:

Water movement was observed by naked eyes.

STATION-C (PLATE-3)

STATION-D (PLATE-4)

Chemical Parameters:

Hydrogen-ion concentration (PH)

To avoid any change in the PH values of water. It was measared at the site by the BDH narrow range PH strips and was confirmed colorimetrically by the portable Lovibond PH Comparator, using univarsal indicators namely, bromothymol blue (PH 6.0-7.6), Phenol red (PH 6.8-8.4) and tymyol blue (PH 8.0-9.6).

Procedure:

In a clean glass tube of the lovibond Comparator lo ml of the water sample was taken and into it 0.5 ml indicator of the required PH range was added. On stirring the indicator a colour developed, which was compared with the colour disc.

Total alkalinity

The standard methods of APHA (1985) were followed. For the estimation of carbonate (Phenol phthalein) and for bicarbonate (methyl orange) were used for estmation of alkalinity.

Reagents

(a) 0.02 N (N/50) sulphuric Acid :

26.7 ml of sulphuric acid (SP.gr.1.84), was made to one litre with distilled water and standardised against 1N sodium carbonate solution.0.02 N (N/50) sulphuric acid was prepared by making the calculated amount of standardised solution of sulphuric acid to one litre with distilled water.

(b) Standard 0.02 N (N/50) Na_2 Co_3 :

To make 0.1N Na_2Co_3 stock solution, 5.3 gm anhydrous Na_2 Co_3 was carefully dessicated and dissolved in one litre of distilled water. 0.02 N (N/50) Na_2 Co_3 was prepared from the stock solution (0.1N, Na_2 Co_3) diluting it to 250 ml.

(c) Phenolphthalein (indicator)

50 mg of phenolphthalein indicator was dissolved in 100 ml of 50% alcohol.

(d) Methyl orange (indicator)

50 mg of methyl orange indicator was dissolved in 100 ml of distilled water.

Procedure

(i) Carbonate alkalinity:

4-6 drops of the phenolphthalein indicator were added in an Erlenmeyer flask containing 100 ml. Of sample water and placed on a white porcelein tile. If the sample remained colour less phenolphthalien alkalinity was zero. However, if the sample turned pink, it was titrated with 0.02 N (N/50) sulphuric acid to a colourless end point.

Calculation

Phenolphthalien alkalinity mg/l= number of ml of 0.02N $H_2\,So_4$ used x 10

(ii) Bicarbonate alkalinity:

The bicarbonate (Mo) alkalinity was determined by the procedure (Vide Supra) but with methyl orange, as indicator. The colour of the sample changes from yellow to faint orange that is the end point.

Calculation:

Mo alkalinity mg/1= Number of ml of 0.02 N $H_2\,So_4$ used x 10

Chloride:

Chlorine was estimated as chloride (Mohr's method, APHA).

Procedure:

100 ml of the sample water was titrated with N/35.5 Silver nitrate, using 5 percent potassium chromate ($K_2 Cro_4$) as indicator. The end point comes when brick red colour appears.

Calculation:

Chloride mg/1= Number of ml of N/35.5 Ag no_3 used x 10

Phosphate:

The phosphates were estimated by stannous chloride method.

Reagents:

(a) Ammonium molybdate (acidified).

(b) Stannous chloride.

(c) Standard phosphates solution ($KH_2 Po_4$).

Procedure:

A series of temporary standards of phosphates were prepared by adding known volumes-0.2,0.4,0.6,0.8,1.0 and 1.2 ml of standard phosphate solution in the Nessler's tubes by adding 4 ml molybdate reagent and 1 ml stannous chloride reagent with thorough mixing. 50 ml sample was taken and added 4 ml molybdate reagent and 1 ml stannous chloride solution. The colour so developed was matched with the standards.

Calculation:

$$\text{Phosphate mg/1} = \frac{\text{Number of mlof } KH_2 Po_4 \text{ Standard used X 1000}}{\text{Volume of Sample}}$$

Dissolved oxygen

The dissolved oxygen was estimated by winkler's method using alsterberg

azide modification. The sample were carefully preserved at the sampling stations and the analysis was done at the earliest before 10 hrs.

Reagents:

(a) Alkaline iodide:

750 ml of distilled water, 500 gm. of pure sodium hudroxide, 150 gm, of potassium iodide and 20 gm of sodium azide were dissolved and then made upto one litre with distilled water.

(b) Manganous sulphate:

250 ml of distilled water was taken in a beaker and 450 gm of $Mn\ So_4\ 4H_2o$ was added. The volume was made upto one litre with distilled water.

(c) Concentrated sulphuric acid (SP.gr. 1.84)

(d) 0.025N (N/40) Sodium thosulphate:

The standard solution (0.1N) of sodium thiosulphate was prepared by dissolving 24.82 gm ($Na_2\ S_2o3.5\ H_2o$ in 700 ml of distilled water, later 4 gm of Borax ($Na_2\ B_4o7.\ 10H_2o$) was added as stabilizer. This solution was diluted four times to from 0.025 N Sodium thiosulphate solution.

(e) Starch Solution:

To a suspension of 2 gm powdered starch in 350 ml of distilled water, 30 ml of 20 percent Na oH solution was neutralised with HCl using litmus as indicator. The starch solution was acidified with 1 ml of glacial acetic acid.

Procedure:

Water sampling for the estimation of Dissolved oxygen (Do) was done carefully, to avoid any mixing of free oxygen in the form of air bubbles. The water samples were collected from sub-surface by the help of Do bottles of 300 ml

Capacity. The bottles were immersed in water and filled completely till the water had over flown twice or thrice. the capacity of the bottles. The bottles were stoppered under water. Immediately after the bottles were brought to the surface 2 ml each of manganous sulphate and alkaline iodide reagents were added by means of a pipette which was dipped to the bottom of the bottle and slowly taken out after adding the reagents.The stopper was replaced and the bottle inverted three or four times for homogenous mixing the reagents with water samples. The formation of a flocculent precipitate confirmed that the Dissolved oxygen has been fixed.

The samples were analysed in the laboratory for that quantitative estimation, 2 ml conc. Sulphuric acid was added in each sample and the precipitate was dissolved by the gradual shaking of the bottles. The volume corresponding to 200 ml of original sample was taken for titration. The volume of treated sample taken was calculated by the following formula:

$$\frac{\text{Exact capacity of the bollte x 200}}{\text{Exact capacity-4 ml}}$$

The Calculated valume of the treated sample was titrated with 0.025 N sodium thiosulphate solution. Firstly few ml titrant was added till the colour of sample changed from brown to somewhat pale, then 1 ml starch solution was added as indicator,the colour became somewhat black. It was further titrated till the black colour changed from black. to blue. The titration was completed when it turned colourless.

Calculation:

$$\text{Dissolved oxygen mg/l} = \frac{\text{Number of mlof } Na_2\ S_2o3 \text{ used x1000}}{\text{Volume of Sample}}$$

Ammonical Nitrogen (NH_4-N):

Direct Nesslerization method was adopted for this parameter. To 50 ml of sample, 5drops of Rochelle salt solution and 2 ml of Nessler's reagent was added. After 10 minutes intensity of colour was measured on spectro photometer at 420 nm wave-length. Value of NH_4-N was obtained from standard curve.

Nitrite Nitrogen (No_2-N):

I ml of each sulfanilic alid Naphthylamine Hydrochloride and sodium acetate solutions in sequence were added in 50 ml of colour less filtered sample a winered colour of nitrite appeared and determined at 520 nm wave length and the value of $N0_2$-N was calculated in mg/1 directly from the standard curve.

Nitrate Nitrogen (No_3-N):

Phenol disulphonic acid method was chosen for this parameter. 50 ml of water sample was evaporated in water bath. Residue was dissolved in 1,2,4 phenol disulphonic acid. on addition of ammonia solution yellow colour alkaline salt was formed and determined at 510 nm, Wave length. value of No3-N in mg/1 was found out by standard curve.

Corbon-di-oxide:

As this gas is liable to escape easily from the sample. So its analysis was done immediately after collection.

Reagents:

N/44 NaoH; 4 gm of A.R. quality NaOH is dissolved in 1 litre of distilled water, which gives 0.1 N NaoH. standardise this solution with 0.1 NH_2 So_4 using phenol phthalein indicator. 100 ml of this solution is diluted to 440 ml gives N/44 NaoH.

Procedure:

50 ml of water sample was taken in a conical flask and added 2 drops of phenolphthalein indicator. If the colour of water turns pink, there is no co_2 present, but if the water remains colourless, added indicator drop by drop with the help of a graduated 10 ml pipette with gentle stirring till the colour turned pink.

Biological parameters:

Aquatic weeds

The samples of aquatic weeds were collected and their abundance was assessed by visual observations and identified up to species level according to Hooker (1872-1997) and Subramanyan (1962).

Planktons

The phyto and zooplanktons were collected by means of plankton net (welch, 1948) and preserved at the site. The bolting silk No. 25 (65n) was used in the net. Which is attached with an iron ring of about 20 cm diameter in conical shape. The open tail side is of about 2.3 cm in diameter was tied firmly to a glass tube measuring 5 cm in length and 2 cm in diameter. In each collection 25 lit of surface water was collected by means of a jug, which was filtered through the plankton net. The filtrate thus contained planktons (Phyto and zooplankton). 10 ml of the filtrate was preserved in 4 percent formalin at the spot. The quantitative and qualitative examination was done in the laboratory by the standard methods (A.P.H.A, 1985 18th Ed.) and Goyal and Trivedi 1986.

Before analysis each plankton sample was diluted and mixed with water to make it to 50 ml, 1 ml of this (Sub-sample) was drawn quickly with a wide mouthed pipette and poured into a sedgewick-Raftar plankton counting cell. All the organisms & were identified up to species. Analysis of each species was then calculated as No/litre of the water by the formula given by Welch's (1948).

$$n = [(a x 1000) C]/1$$

Where,

n = No. of plankton per lit.

a = Average No. of plankton in all count in a counting cell.

c = Volume of original concentrate, expressed in litres.

l = Valume of original water expressed in litre.

Fishes sampling and analysis techinque :-

The fishes were collected during night or early in the morning by line and bait method and also with vertical nets (100'x5') with a mesh (3'x5') in diamiter and its identified with help of francis day fauna.

Soil Sampling

To obtain a Composite sample, small portions of soil were collected up to the desired depth (0.15 cm) by means of suitable sampling tools from atleast 10 to 15 well distributed spots (from each sampling unit) after scrapping off the sarface layer. The soil collected in this manner was thoroughly mixed on a clean piece of cloth, polythene sheet or thick paper and the bulk reduced by quartering and about 500g (1/2 kg) of the composite sample is retained. The soil was quickly air dried in shade at room temperature and put in cloth or polythene bags with particular marks.

Sampling tools:

Samples can be drawn with any of these hand implements namely, (i) Soil tube (auiger), (ii) screwtype auger, (iii) Post-hole augher, (iv) Kassi (spade) and (v) Khurpi (a common gardening hand tool).

Analysis of soil:

Chemical analysis:

The Chemical analysis of soil was done for the estimation of p^H Nitrogen, phosphorus and pottasium of the factors as per the methods of APHA.

Soil pH:

50 ml distilled water was taken in a conical flask. Then 20 gms of soil sample was added to it and shaked for five minutes. Then the mixture was kept for 30 minutes. The glass electrode of pH meter was immersed in to it to record the pH.

Soil nitrogen:

Five grams of soil was taken in a filter paper pocket in a kjeldahel flask. Two grams of salicyclic acid and 35 ml concentrated sulphuric acid was added to it. The content was swirled and allowed to react in cold for 30 minutes. Five grams of sodium thiosulphate was added to it followed by 20 grams of digestion mixture and mixed thoroughly the kjeldahal flask was heated till contents become green. Then the contents with distilled water was transferred to distillation flask. The receiver was placed with 4 percent boric acid containing two drops of mixed indi cator and delivery tube was put in side flask evolution of ammonia subsides. The distilate was titrated with standard 0.1 N Hydrochloric acid till Pink colour just appeared.

Soil Phosphorus (troughs methods):

Reagents:

(a) 0.02 $NH_2\ So_4$- Dilute 100 ml of 0.02 $NH_2\ So_4$ (Standardised) to litre. Adjust the pH to 3.0 with 4 m-sulphate.

(b) 50% of $H_2\ So_4$

(c) 10% Ammonium molybdate.

(d) Stannous chloride-2.15 g of A.R. quality stannous chloride in 20 ml conc. Hcl add sufficient distilled water to make upto 100 ml and place a small piece of metallictin in the bottle.

(e) Acid-Ammon-malybdate-15 ml of 50% $H_2\ So_4$ to 5 ml of 10% amn-molybdate. This should be prepared fresh at the time of analysis.

(f) Standard phosphate soln (1 ml = 0.01 mg p)- 4.388 g of potassium dihydrogen phosphate ($KH_2\ Po_4$) dissolved in phosphate free distilled water and made

upto 1 litre. This soln contains 1 mg/ml. 10 ml of this soln diluted to 1 litre (0.01 mg/ml)

Procedure:

Place 1gm. of air dried powdered soil in 250 ml bottle. Add 200 ml of 0.002 $NH_2 So_4$ (P^H adjusted to 3.0 with Am-sulphate). Shaked the mixture for 30 minutes in a mechanical Shaker. Keep it for 10 minutes and filter. Took 50 ml of the soln in a Nessler's tube, added 2 ml of acid amn-molybdate reagent and 2 drops of stannous chloride, mixed gently waited for five minutes; and matched the blue colour developed with stannous phos phate solutions of different concentration in phosphate free distilled water.

Soil Pottasium:

Reagents:

(1) Neutral normal ammonium acetate-solution of 2 N acitic acid (Glacial) and 2 N ammonium hydroxide where prepared and equal volumes of the two where mixed in a large beaker and the pH adjusted to 7.0 with acid or ammonium hydroxide.

(2) Potassium chloride solution:

A stock solution of 1000 mg K/ml was made by dissolving 1.008 gm. of A.R. potassium chloride (dried at 60^0 c for 1 hour) in distilled water and making up to litre.

Procedure:

5 gram of soil is shaken with 25 ml neutral normal ammonium acetates till 5 minutes and filtered immediatly by the rough a dry filter paper (what mann) fist few ml of the fillrate was rejected potassium concentration in the extract was determined in the flame photometer after necessary calibration of the instrument.

Calculations:

$$\text{Available K (kg/ha)} = \frac{\text{R x Volume of the extract x 22.4}}{\text{wt. of soil taken}}$$

Meterological condition:

1- Atmospheric temperature:

Atmospheric temperature was recorded in the field by using standard centrigade thermometer.

2- Relative humidity:

Humidity was measured by hygrometer.

3- Rain fall:

It was measured by rain guage/rain graph.

4- Photoperiod:

Sunrise/sunset were recorded in hrs and minutes.

OBSERVATION

OBSERVATION

The hydrobiology of the Keerat Sagar was studied monthly for the period of two years from (December, 2001 to November, 2002 and December, 2002 to November, 2003).

Meteorological Conditions :

The meteorological conditions of Mahoba city were recorded during the study period of two years. The average values are as under :

1. Atmosperic temperature :

The atmospheric temperature during the present study period of 2001-2002 varied between 8.5^{0}C to 41.3^{0}C and in 2002-2003 ranged between 7.0^{0}C to 41.5^{0}C. Maximum mean value was recorded in the month of June 41.4^{0}C while the minimum mean value was recorded in the month of January 7.8^{0}C (Table- I and II, Fig. 1, 2).

2. Rainfall :

The rain fall during the present study period of 2001-2002 varied between 3.8mm. to 248.32mm. and in 2002-2003 ranged between 1.0mm. to 134.60mm. Maximum mean value was recorded in the month of August 191.46mm. while the minimum mean value was recorded in the month of December 2.4mm. (Table- I & II).

3. Relative Humidity :

Humidity during the present study period 2001-2002 varied from 20.12% to 81.16% and in 2002-2003 ranged between 16.17% to 79.13%. Maximum mean value was recorded in the month of August 80.14% while the minimum mean value was recorded in the month of May 18.14 (Table- I & II).

4. Photoperiod :

The photoperiod during the present study period 2001-2002 varied between 10.20hrs to 13.30hrs. and in 2002-2003 ranged between 10.18hrs. to 13.20hrs. Maximum mean value was recorded in the month of May 13.25hrs. while the minimum mean value was recorded in the month of December 10.19hrs. (Table-I & II).

Physico-Chemical Factors

The physical factors are water temperature water movement, Depth, Colour Turbidity and chemical factors are- pH, Alkalinity, Chlorides, Dissolved Oxygen, Carbon-di-oxide, Phosphate and Ammonical nitrogen.

Physical factors :

Water Temperature :

During the study period the temperature of Keerat Sagar water varied between 20°C to 32.4°C in the year 2001-2002 and between 14.6°C to 32.5°C in the year 2002-2003 at four sampling stations. Maximum mean value was recorded in the months of June 32.4°C while the minimum mean value was recorded in the months of January.

The range of fluctuation of temperature was found very little at the four different sampling stations (Table 3-10, Fig. 4-11).

Water Movement :

The movement of the water is affected by wind velocity. Therefore the maximum movement of water was found in the months of summer season (May and June) and rainy season's the months (July and August). The movement of water was observed compariatively less and in rainy season's months (July and August) whereas the movement of water in winter season's months (January and Febuary) was recorded minimum.

Depth :

The impact on the depth of water is due to inflow and rainfall. Hence, the depth of water fluctuated in summer and rainy season.

The maximum depth was measured in rainy season, while minimum in summer because of the above mentioned factors. The average depth of the Keerat Sagar is 3.75metre.

Colour :

The colour of water in Keerat Sagar was found to vary from green to muddy. The greenish colour of the water in the months of October to February. In July to August months the muddy colour was found. Whereas in June month water became dirty and in September month the colour of water was muddy green in 2001-2002. The same colour of water was observed in 2002-2003.

Turbidity :

In the present study the turbidity ranged from 14.02 to 62.00 NTU during the 2001-2002 and 15.20 to 69.20 NTU in the 2002-2003. Maximum mean value was recorded in the month of August 65.6NTU while the minimum mean value was recorded in the month of December 14.61 NTU.

The higher trend of turbidity was observed during monsoon and summer period (Table 3-10, Fig. 12.19).

Chemical Factors

Hydrogen-Ion Concentration :

The pH value was observed in the alkaline range throughout the study period. During the present study period 2001-2002 varied between 7.5 to 8.6 and in 2002-2003 ranged between 7.4 to 8.2 maximum mean value was recorded in the month of

march 8.4 while the minimum mean value was recorded in the month of August 7.4 (Table 3-10, Fig. 20-27).

Carbonate :

The carborate during the present study period of 2001-2002 varied between 5.50 to 17.50 ppm and in 2002-2003 ranged between 6.75 to 16.40 ppm. Maximum mean value was recorded in the month of December 17.00 ppm while the minimum mean value was recorded in the month of May 6.12ppm. (Table 3-10, Fig. 28-35).

Bicarbonate :

The bicarbonate during the present study period of 2001-2002 varied between 136.30 to 196.30ppm and in 2002-2003 ranged between 136.20 to 198.50ppm. Maximum mean value was recorded in the month of July 197.4ppm while the minimum mean value was recorded in the month of November 136.20ppm (Table 3-10, Fig. 28-35).

Total Alkalinity :

The total alkalinity during the present study period 2001-2002 varied between 147.8 to 208.8ppm and in 2002-2003 ranged between 147.2 to 210.48ppm. Maximum mean value was recorded in the month of July 209.14 while the minimum mean value was recorded in the month of November 147.5 (Table 3-10, Fig. 28-35).

Chloride :

The chloride during the present study period of 2001-2002 was found 10-00 to 46-10ppm and in 2002-2003 ranged between 11.20 to 43.50ppm. Maximum mean value was recorded in the month of June 44.8ppm while the minimum mean value was recorded in the month of August 10.6ppm (Table 3-10, Fig. 36-43).

Ammonical Nitrogen :

The ammonical nitrogen in the present study period of 2001-2002 varied between 0.28 to 0.80ppm and in 2002-2003 ranged between 0.35 to 0.82ppm. Maximum mean value was recorded in the month of June 0.81 while the minimum mean value was recorded in the month of November 0.31 (Table 3-10, Fig. 41-51).

Phosphate :

The phosphate in the present study period of 2001-2002 varied between 0.21 to 0.72ppm and in 2002-2003 ranged between 0.26 to 0.73ppm. Maximum mean value was recorded in the month of June 10.72ppm while the minimum value was recorded in the month of November 0.23 (Table 3-10, Fig. 52-59).

Dissolved Oxygen :

Dissolved oxygen during the present study period of 2001-2002 was found 3-38 to 7.60ppm and in 2002-2003 ranged between 3.75 to 8.40ppm. Maximum mean value was recorded in the month of November 8.00ppm while the minimum mean value was recorded in the month of June 3.56ppm. (Table 3-10 Fig. 60-67).

Carbon-di-oxide :

The carbon-di-oxide during the present study period 2001-2002 varied between 8.40 to 22.70ppm and in 2002-2003 ranged between 7.90 to 23.60ppm. Maximum mean value was recorded in the month of May 23.15ppm. while the minimum mean value was recorded in the month of December 8.15ppm. (Table 3-10, Fig. 68-75).

Biological Factors :

Biological characteristics of Keerat Sagar which were considered here are : aquatic weeds i.e.- submerged, free floating, marginal emergent, marginal and floating weeds and plankton i.e.- phytoplankton and Zooplankton and fishes.

Aquatic weeds :

The aquatic weeds of Keerat Sagar were examined monthly during both the yrs. They are as follows :

S. No.	Name of Species	Type of Weeds
1.	Trapa natans	FF
2.	Eichhornia crassipes	FF
3.	Cyperus corymbosus	M
4.	Ipomea aquatica	M
5.	Nelumbo spp	FF
6.	Potamogeton indicus	E
7.	Nazas minor	S
8.	Spirudilla polyrhiza	FF
9.	Polygonum glabrum	M
10.	Ceratophylium demersum	S
11.	Pistia spp	FF
12.	Vallisneria spiralis	S
13.	Lemna paucicostata	FF
14.	Azolla spp.	FF

Ff = Free floating weeds, M = Marginal weeds, S = Submerged weeds, E = Emergent weeds.

Plankton :

Phytoplankton :

The phytoplankton of Keerat Sagar were examined monthly during both the yrs. They are as follows .

In the present investigation only dominant groups of phytoplankton were studied qualitatively and quantitatively and identified upto genus as follows.

Group (A) Chlorophyceae :

Represented by only eight genera (i) Coclostrum (ii) Spirogyra (iii) Zygnema (iv) Ulothrix (v) Tetraspora (vi) Protococcus (vii) Actinastrum (viii) Scnedesmus.

Group (B) Bacillriophyceae :

Represented by only 4 genera (i) Navicula (ii) Frustulia (iii) Synedra (iv) Diatoma.

Group (C) Myxophyceae :

Represented by only 4 genera (i) Microcysista (ii) Tetraspedia (iii) Anabaena (iv) Oscillatoria.

Zooplankton :

The zooplankton population mainly consists of protozoans, rotifers and planktonic forms of crustaceans (Jhingran, 1977).

In the present investigation only dominant groups of Zooplankton were studied, qualitatively and quantitatively and identified up to genus as follows :-

Group (A) Protozoa :

Represented by only four genera (i) Paramecium (ii) Euglena (iii) Euglypha (iv) Vorticella.

Group (B) Rotifera :

Represented by only six genera (i) Brachionus (ii) Filinia (iii) Keretella (iv) Testudinella (v) Philodina (vi) Asplanchna.

Group (C) Crustacea :

(a) Copepoda (Sub group):-

Represented by only four genera (i) Cyclops (ii) Mesocyclops (iii) Eggs and Nauplii (iv) Diaptomus.

(b) (Sub group):

Represented by only three genera- (i) Daphnia (ii) Ceriodaphnia (iii) Alonella.

Fishes :

The fishes were dragged out and were identified monthly during both the years. They are as follows :-

1. Labeo rohita
2. Labeo colbasu
3. Catla catla
4. Cirrihinus mrigala
5. Wallago attu
6. Heteropneustes fossilis
7. Chanda nama
8. Chanda ranga
9. Mystus seenghala
10. Clarius batrachus
11. Notopterus chhitala
12. Channa marulius

Soil Analysis :

The soil of the Keerat Sagar analysed during two yers their chemicals factors given in the following table :-

pH :

The soil pH during the present study period of 2001-2002 varied between 8.0 to 8.6 and in 2002-2003 ranged between 8.0 to 8.4. Maximum mean value was 8.6 recorded in the months of December. While the minimum mean value was 8.0 recorded in the month of August (Table 29-30).

Nitrogen :

The soil nitrogen during the present study period of 2001-2002 ranged between very low (VL, 0 - .25ppm) to high above (H_1 above .80ppm) and in 2002-2003 ranged between very low (Vl, 0 - .20ppm) to high (H - .85ppm) maximum value was recorded in the month of march, April and May while the minimum value was recorded in the month of July, August and September (Table 29-30).

Phosphorus :

The soil phosphorus during the present study period of 2001-2002 ranged between very low (L, 10.15 - 20.0 ppm) to high (H - above - 42.0 ppm) and in 2002 - 2003 ranged between low (L, 10.20 to 22.0ppm) to high (H, above 40.0ppm) maximum value was recorded in the months of November, December and January while the minimum value was recorded in the months of April and May (Table 29-3).

Potassium :

The potassium during the present study period 2001-2002 ranged between low (L, 50 - 105ppm) to high (H, above 255ppm) and in 2002 - 2003 ranged between low (L, 55 - 100ppm) to high (H, above 250ppm) Maximum value was recorded in the months of Feburary, March and April while the minimum value was recorded in the months of August and September (Table 29-30).

Table - 1

Meteorological Data

(Monthly average, December 2001- November-2002)

S.No.	Month	Atmospheric temp.		Relative Humidity (%)		Monthly rain fall ((mm)/%	Photo period (Hrs.)
		Maximum (0^0C)	Minimum (0^0C)	Morning	Evening		
1	December	23.2	10.0	32.22	24.21	0	10.20
2	January	23.9	8.5	32.18	25.16	0	10.30
3	February	28.5	12.5	40.21	27.58	9.8	11.10
4	March	39.0	17.5	30.16	22.12	0	11.35
5	April	41.3	23.4	38.81	26.18	7	12.45
6	May	40.6	28.3	33.99	22.34	3.9	13.30
7	June	39.8	29.0	32.96	20.21	3.8	13.34
8	July	38.8	28.5	46.68	29.11	25.47	13.25
9	August	32.5	25.6	81.16	68.06	248.32	12.56
10	September	31.4	24.2	54.56	32.18	86.31	11.51
11	October	30.0	20.5	46.66	20.12	0	11.00
12	November	27.5	15.1	44.31	27.56	0	10.45
	Total					384.6	

The data were obtained from the telegraph office, Mahoba.

Table - 2

Meteorological Data

(Monthly average, December 2002- November-2003)

S.No.	Month	Atmospheric temp.		Relative Humidity (%)		Monthly rain fall ((mm)/%	Photo period (Hrs.)
		Maximum (0^0C)	Minimum (0^0C)	Morning	Evening		
1	December	24.1	10.9	40.45	26.31	1.00	10.18
2	January	18.2	7	54.55	32.50	0.00	10.22
3	February	23.9	17.8	52.45	30.12	16.40	11.10
4	March	32.2	16.4	40.00	28.10	2.53	11.42
5	April	38.7	23.1	35.12	27.62	0.00	12.33
6	May	40.7	25.9	30.15	16.17	0.00	13.02
7	June	41.5	28.6	55.02	34.46	65.50	13.20
8	July	34.2	29.3	65.54	55.06	96.60	13.16
9	August	33.2	27.3	79.13	59.41	134.60	12.46
10	September	32.0	25.5	55.21	36.16	80.65	11.74
11	October	28.1	21.3	51.21	30.16	36.54	11.22
12	November	27.2	18.4	49.64	27.1	0.00	10.52
	Total					433.82	

The data were obtained from the telegraph office, Mahoba.

Table- 3
Physico--Chemical Factors

Station-A **Period : 2001-2002**

S. No.	Month	Temperature of Water (0^0C)	Turbidity (NTU)	Colour	Hydrogen ion concentration	Carbonate (ppm)	Bicarbonate (ppm)	Total Alkalinity	Chloride (ppm)	Ammonical nitrogen (ppm)	Phosphate (ppm)	Dissolves oxygen (ppm)	Carbon- di-oxide (ppm)
1	December	21.00	14.02	Green	8.0	16.0	140.0	156.0	19.00	0.35	0.25	7.40	8.9
2	January	20.80	15.00	Green	8.2	15.5	144.2	159.7	27.20	0.37	0.29	7.50	9.2
3	February	22.00	18.02	Greenish	8.1	150.2	150.2	164.2	30.00	0.40	0.37	7.10	10.05
4	March	25.20	19.00	Greenish	8.3	158.1	158.1	170.1	36.20	0.50	0.45	6.00	15.6
5	April	29.80	20.00	Green	8.2	172.4	172.4	181.6	24.60	0.58	0.50	5.02	16.2
6	May	31.30	20.60	Green	8.0	173.8	173.8	180.2	30.20	0.68	0.62	4.02	20.2
7	June	32.40	29.00	Dirty	8.0	186.7	186.7	196.2	45.00	0.78	0.65	3.50	19.4
8	July	30.00	38.12	Muddy	7.8	187.3	187.3	197.5	35.15	0.76	0.70	4.20	18.2
9	August	29.80	61.10	Muddy	7.6	186.2	186.2	195.7	10.00	0.62	0.68	5.90	16.4
10	September	29.30	54.20	Muddy green	7.6	151.1	151.1	158.0	15.60	0.48	0.50	6.00	13.1
11	October	28.60	33.40	Greenish	8.1	142.6	142.6	149.5	24.00	0.40	0.38	6.05	12.6
12	November	24.30	28.00	Green	8.0	136.3	136.3	147.8	33.10	0.38	0.31	7.50	10.6

All measurments in ppm (mg/l) except temperature 0^0C and pH in pH Unit and Turbidity in N.T.U.

Table- 4
Physico--Chemical Factors

Station-B **Period : 2001-2002**

S. No.	Month	Temperature of Water (0^0C)	Turbidity (NTU)	Colour	Hydrogen ion concentration	Carbonate (ppm)	Bicarbonate (ppm)	Total Alkalinity	Chloride (ppm)	Ammonical nitrogen (ppm)	Phosphate (ppm)	Dissolves oxygen (ppm)	Carbon- di-oxide (ppm)
1	December	20.2	14.50	Green	7.5	17.40	144.20	161.60	19.80	0.38	0.30	7.30	8.10
2	January	20.0	15.60	Green	7.8	15.30	148.30	163.60	28.00	0.40	0.31	7.35	9.40
3	February	21.5	18.90	Greenish	8.0	13.50	154.10	167.60	30.90	0.42	0.37	7.00	10.80
4	March	24.7	19.40	Greenish	7.8	11.20	160.40	171.60	37.00	0.48	0.44	5.90	15.80
5	April	28.5	20.75	Green	7.8	8.50	175.80	184.30	25.00	0.56	0.50	4.90	16.90
6	May	30.0	21.05	Green	7.7	5.80	178.90	184.70	31.00	0.65	0.61	3.95	21.30
7	June	32.0	30.10	Dirty	7.6	8.40	190.60	199.00	46.00	0.79	0.69	3.38	17.80
8	July	29.0	39.00	Muddy	7.5	11.80	193.20	205.00	36.00	0.78	0.72	4.14	21.80
9	August	28.5	62.00	Muddy	7.5	11.00	184.10	195.10	10.80	0.55	0.68	5.80	18.20
10	September	28.8	55.05	Muddy green	7.5	6.50	162.50	169.00	16.00	0.51	0.48	5.90	16.60
11	October	27.5	34.00	Greenish	7.7	9.50	150.70	160.20	24.50	0.42	0.39	5.95	15.70
12	November	23.8	28.75	Green	7.9	13.00	141.20	154.20	34.15	0.35	0.31	7.40	14.30

All measurments in ppm (mg/l) except temperature 0^0C and pH in pH Unit and Turbidity in N.T.U.

Table- 5
Physico--Chemical Factors

Station-C **Period : 2001-2002**

S. No.	Month	Temperature of Water (0^0C)	Turbidity (NTU)	Colour	Hydrogen ion concentration	Carbonate (ppm)	Bicarbonate (ppm)	Total Alkalinity	Chloride (ppm)	Ammonical nitrogen (ppm)	Phosphate (ppm)	Dissolves oxygen (ppm)	Carbon- di-oxide (ppm)
1	December	20.5	15.00	Green	8.1	17.50	148.30	165.80	20.00	0.40	0.36	7.28	8.12
2	January	20.4	15.80	Green	8.2	15.50	150.20	165.70	28.20	0.42	0.38	7.38	9.60
3	February	21.5	19.00	Greenish	8.0	12.80	155.60	168.40	31.00	0.43	0.37	6.95	10.90
4	March	24.7	19.50	Greenish	8.2	11.00	163.80	174.80	37.20	0.45	0.40	5.92	16.50
5	April	28.5	20.70	Green	8.2	8.50	175.60	184.10	25.15	0.50	0.47	4.91	16.80
6	May	30.0	21.00	Green	8.2	5.50	180.70	186.20	31.10	0.66	0.55	3.98	22.70
7	June	31.8	30.00	Dirty	8.0	8.60	194.90	203.50	46.10	0.79	0.65	3.40	22.40
8	July	29.0	38.70	Muddy	7.9	12.50	196.30	208.80	36.20	0.80	0.70	4.18	20.60
9	August	28.6	61.93	Muddy	7.5	8.50	188.20	196.70	11.00	0.63	0.09	5.83	19.40
10	September	28.7	55.00	Muddy green	7.8	6.50	168.30	174.80	16.10	0.55	0.45	5.93	17.30
11	October	27.5	34.00	Greenish	7.7	10.50	155.60	166.10	24.60	0.48	0.39	5.98	15.50
12	November	23.7	28.70	Green	8.0	13.40	144.50	157.90	34.50	0.39	0.32	7.45	14.80

All measurments in ppm (mg/l) except temperature 0^0C and pH in pH Unit and Turbidity in N.T.U.

Table- 6
Physico--Chemical Factors

Station-D **Period : 2001-2002**

S. No.	Month	Temperature of Water (0^0C)	Turbidity (NTU)	Colour	Hydrogen ion concentration	Carbonate (ppm)	Bicarbonate (ppm)	Total Alkalinity	Chloride (ppm)	Ammonical nitrogen (ppm)	Phosphate (ppm)	Dissolves oxygen (ppm)	Carbon- di-oxide (ppm)
1	December	21.2	14.10	Green	8.5	17.50	140.02	157.70	19.15	0.36	0.27	7.42	8.40
2	January	20.2	15.20	Green	8.1	15.60	145.50	161.10	28.50	0.38	0.32	7.50	9.10
3	February	21.7	18.40	Greenish	8.0	13.50	152.40	165.90	30.20	0.42	0.38	7.15	10.20
4	March	23.0	19.20	Greenish	8.6	11.50	159.30	170.80	36.30	0.46	0.40	6.10	14.80
5	April	28.7	19.85	Green	8.0	8.90	172.50	181.40	24.80	0.53	0.47	5.05	17.20
6	May	30.6	20.50	Green	8.0	6.50	170.90	177.40	30.50	0.63	0.60	4.10	20.10
7	June	32.0	28.60	Dirty	7.5	9.40	187.80	197.20	45.50	0.71	0.62	3.55	19.20
8	July	29.7	38.00	Muddy	7.5	12.00	189.40	201.40	35.60	0.76	0.68	4.22	18.10
9	August	29.0	61.00	Muddy	7.6	10.50	185.60	196.10	10.40	0.48	0.60	6.00	16.20
10	September	29.0	54.00	Muddy green	7.8	6.50	152.30	158.80	15.80	0.47	0.49	6.10	13.80
11	October	28.7	33.00	Greenish	8.0	5.50	143.70	149.20	24.20	0.43	0.38	6.06	12.80
12	November	24.0	27.80	Green	8.1	10.40	138.40	148.80	33.35	0.36	0.28	7.60	11.80

All measurments in ppm (mg/l) except temperature 0^0C and pH in pH Unit and Turbidity in N.T.U.

Table- 7

Physico--Chemical Factors

Station-A **Period : 2002-2003**

S. No.	Month	Temperature of Water (0^0C)	Turbidity (NTU)	Colour	Hydrogen ion concentration	Carbonate (ppm)	Bicarbonate (ppm)	Total Alkalinity	Chloride (ppm)	Ammonical nitrogen (ppm)	Phosphate (ppm)	Dissolves oxygen (ppm)	Carbon- di-oxide (ppm)
1	December	15.9	18.50	Green	8.1	16.40	142.7	159.1	19.50	0.34	0.26	8.00	8.50
2	January	15.6	15.20	Green	8.2	15.80	145.4	161.2	28.40	0.36	0.28	8.05	9.10
3	February	18.6	16.30	Greenish	8.0	14.50	152.5	167.0	31.00	0.38	0.31	7.16	10.30
4	March	22.7	16.20	Greenish	8.2	13.00	158.1	171.1	36.50	0.46	0.39	6.35	14.90
5	April	26.4	20.80	Green	8.2	10.00	175.2	185.2	25.00	0.51	0.43	5.20	15.80
6	May	30.5	21.00	Green	8.2	6.75	176.5	183.3	42.70	0.62	0.54	4.56	19.80
7	June	31.3	29.50	Dirty	8.0	9.80	188.6	198.4	32.60	0.72	0.65	4.10	20.90
8	July	30.6	40.25	Muddy	7.9	10.50	190.2	200.7	36.00	0.70	0.68	5.00	19.80
9	August	28.2	65.50	Muddy	7.5	9.70	186.2	195.9	11.20	0.68	0.70	6.50	18.10
10	September	27.0	58.50	Muddy green	7.8	7.50	155.9	163.4	16.00	0.45	0.38	6.85	17.80
11	October	24.8	33.80	Greenish	7.7	7.00	145.5	152.5	24.50	0.32	0.27	7.00	13.20
12	November	20.1	29.00	Green	8.0	10.00	138.4	148.4	34.20	0.30	0.26	8.40	11.70

All measurments in ppm (mg/l) except temperature 0^0C and pH in pH Unit and Turbidity in N.T.U.

Table- 8
Physico--Chemical Factors

Station-B **Period : 2002-2003**

S. No.	Month	Temperature of Water (0^0C)	Turbidity (NTU)	Colour	Hydrogen ion concentration	Carbonate (ppm)	Bicarbonate (ppm)	Total Alkalinity	Chloride (ppm)	Ammonical nitrogen (ppm)	Phosphate (ppm)	Dissolves oxygen (ppm)	Carbon- di-oxide (ppm)
1	December	15.5	19.00	Green	8.0	15.20	145.30	160.50	20.50	0.39	0.31	8.00	8.12
2	January	14.6	15.50	Green	8.2	15.50	149.80	165.30	27.60	0.41	0.37	7.90	9.30
3	February	18.5	16.50	Greenish	8.1	15.10	155.40	170.50	31.50	0.42	0.36	7.13	11.00
4	March	22.0	16.80	Greenish	7.9	13.50	161.30	174.80	37.00	0.47	0.40	6.30	15.90
5	April	26.8	21.60	Green	8.0	10.40	175.60	186.00	25.60	0.57	0.49	5.08	16.80
6	May	30.5	22.00	Green	7.9	6.80	179.10	185.90	43.00	0.66	0.60	4.50	22.40
7	June	31.5	30.14	Dirty	7.9	10.02	192.30	202.30	33.00	0.80	0.75	4.11	21.80
8	July	30.0	42.00	Muddy	7.5	11.09	195.40	206.50	36.40	0.80	0.70	5.00	22.40
9	August	27.8	68.58	Muddy	7.4	9.50	188.20	197.70	11.60	0.61	0.72	6.45	17.90
10	September	26.9	59.40	Muddy green	7.7	8.20	164.50	172.70	16.50	0.57	0.51	6.80	17.60
11	October	24.7	34.20	Greenish	8.0	7.40	154.80	162.20	24.75	0.46	0.40	6.80	15.80
12	November	20.0	29.60	Green	7.8	10.30	144.80	155.10	34.75	0.38	0.30	8.50	14.90

All measurments in ppm (mg/l) except temperature 0^0C and pH in pH Unit and Turbidity in N.T.U.

Table- 9
Physico--Chemical Factors

Station-C

Period : 2002-2003

S. No.	Month	Temperature of Water (0^0C)	Turbidity (NTU)	Colour	Hydrogen ion concentration	Carbonate (ppm)	Bicarbonate (ppm)	Total Alkalinity	Chloride (ppm)	Ammonical nitrogen (ppm)	Phosphate (ppm)	Dissolves oxygen (ppm)	Carbon- di-oxide (ppm)
1	December	15.6	19.20	Green	8.0	15.26	148.80	164.06	20.18	0.41	0.37	8.15	7.90
2	January	15.8	16.80	Green	7.9	14.28	151.30	165.58	27.78	0.43	0.38	8.00	8.80
3	February	19.0	16.80	Greenish	8.1	15.00	154.60	169.60	32.00	0.43	0.37	7.50	10.20
4	March	22.2	17.00	Greenish	7.7	13.96	165.90	179.86	37.15	0.45	0.39	6.25	15.40
5	April	27.0	21.90	Green	8.0	10.64	178.60	189.24	25.80	0.51	0.41	5.14	16.70
6	May	31.0	22.40	Green	7.6	6.98	181.80	188.78	43.50	0.67	0.57	4.80	22.90
7	June	32.0	30.75	Dirty	8.0	10.26	195.80	206.00	33.50	0.80	0.65	3.75	17.90
8	July	32.5	42.50	Muddy	7.6	11.98	198.50	210.48	36.70	0.82	0.78	4.50	23.60
9	August	28.0	69.20	Muddy	7.5	10.00	190.40	200.40	11.80	0.64	0.70	6.00	19.80
10	September	27.0	60.00	Muddy green	7.9	8.50	170.40	178.90	16.80	0.57	0.49	6.35	17.90
11	October	25.1	35.00	Greenish	7.8	7.86	156.70	164.56	25.00	0.51	0.39	6.70	15.90
12	November	20.5	30.20	Green	7.9	11.00	147.80	158.80	35.00	0.42	0.31	8.00	14.20

All measurments in ppm (mg/l) except temperature 0^0C and pH in pH Unit and Turbidity in N.T.U.

Table- 10
Physico--Chemical Factors

Station-D

Period : 2002-2003

S. No.	Month	Temperature of Water (0^0C)	Turbidity (NTU)	Colour	Hydrogen ion concentration	Carbonate (ppm)	Bicarbonate (ppm)	Total Alkalinity	Chloride (ppm)	Ammonical nitrogen (ppm)	Phosphate (ppm)	Dissolves oxygen (ppm)	Carbon- di-oxide (ppm)
1	December	15.6	19.20	Green	8.0	15.26	138.70	153.96	20.00	0.38	0.26	8.10	8.00
2	January	15.8	16.80	Green	7.9	14.28	140.40	154.68	27.70	0.39	0.33	8.00	9.40
3	February	19.0	16.80	Greenish	8.1	15.00	154.70	169.70	31.10	0.40	0.39	7.00	9.90
4	March	22.2	17.00	Greenish	7.7	13.96	158.40	172.36	36.76	0.42	0.38	6.25	13.80
5	April	27.0	21.90	Green	8.0	10.64	170.20	180.84	25.79	0.50	0.46	5.14	16.90
6	May	31.0	22.40	Green	7.6	6.98	168.60	175.58	42.00	0.59	0.49	4.52	20.60
7	June	32.0	30.75	Dirty	8.0	10.26	188.60	198.86	32.50	0.70	0.60	4.06	20.20
8	July	32.5	42.50	Muddy	7.6	11.98	185.80	197.78	36.15	0.60	0.65	4.90	18.60
9	August	28.0	69.20	Muddy	7.5	10.00	188.70	198.70	11.30	0.65	0.66	6.25	16.10
10	September	27.0	60.00	Muddy green	7.9	8.50	156.00	164.50	16.19	0.45	0.39	6.70	13.60
11	October	25.1	35.00	Greenish	7.9	7.86	140.20	148.06	24.65	0.42	0.38	7.00	12.40
12	November	20.5	30.20	Green	7.8	11.00	136.20	147.20	34.50	0.35	0.27	8.15	10.60

All measurments in ppm (mg/l) except temperature 0^0C and pH in pH Unit and Turbidity in N.T.U.

Table-11

List of Aquatic Weeds

S.No.	Name of Species	Type of Weeds
1-	Trapa natans	FF
2-	Eichhornia crassipes	FF
3-	Cyperus corymbosus	M
4-	Ipomea aquatica	M
5-	Nelumbo Spp	FF
6-	Potamogeton indicus	E
7-	Nazas minor	S
8-	Spirudilla polyrhiza	FF
9-	Polygonum glabrum	M
10-	Ceratophyllum demersum	S
11-	Pistia Spp	FF
12-	Vallisneria spiralis	S
13-	Lemna paucicostata	FF
14.	Azolla Spp	FF

FF = Free floating weeds

M = Marginal weeds

S = Submerged weeds

E = Emergent weeds.

Table- 12

Monthly Variation of Phytoplankton

Station-A **Period : 2001-2002**

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Chlorophyceae													
1	Coelastrum	15	12	10	13	0	0	0	9	6	4	0	0
2	Spirogyra	5	6	0	0	0	0	0	7	0	8	4	5
3	Zygnema	12	12	14	15	0	28	20	15	16	12	10	11
4	Ulothrix	15	16	19	20	22	28	30	0	0	14	9	0
5	Tetraspora	125	135	145	160	172	180	210	200	206	190	180	170
6	Protococcus	50	44	48	50	62	80	86	85	78	70	63	50
7	Actinastrum	26	28	30	36	45	60	80	78	70	60	58	55
8	Scnedesmus	26	28	30	37	42	49	55	64	68	72	71	68
	Total	**274**	**281**	**296**	**331**	**343**	**425**	**481**	**458**	**444**	**430**	**395**	**359**
Bacillariophyceae													
1	Navicula	40	28	44	68	74	80	85	74	71	60	58	50
2	Frustulia	0	5	7	0	9	15	25	22	20	19	17	16
3	Synedra	26	30	28	40	60	65	64	39	42	40	22	20
4	Diatoma	16	14	15	30	35	38	40	45	38	36	30	28
	Total	**82**	**77**	**94**	**138**	**178**	**198**	**214**	**180**	**171**	**155**	**127**	**114**
Myxophyceae													
1	Microcystis	180	195	190	200	210	230	240	248	185	180	172	170
2	Tetraspedia	0	23	18	10	0	0	17	25	22	20	17	20
3	Anabaena	0	0	0	0	20	28	33	15	13	9	8	0
4	Oscillatoria	8	0	0	0	22	40	48	28	24	22	20	18
	Total	**188**	**218**	**208**	**210**	**252**	**298**	**338**	**316**	**244**	**231**	**217**	**208**
	Grand Total	**544**	**576**	**598**	**679**	**773**	**921**	**1033**	**954**	**859**	**816**	**739**	**681**

Table- 13

Monthly Variation of Phytoplankton

Station-B

Period : 2001-2002

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Chlorophyceae													
1	Coelastrum	18	20	10	15	0	0	0	8	9	6	0	0
2	Spirogyra	8	15	0	0	0	0	0	10	0	12	8	6
3	Zygnema	15	18	19	22	0	30	22	18	17	16	10	9
4	Ulothrix	18	20	22	25	30	32	35	0	0	19	10	0
5	Tetraspora	128	140	142	165	170	185	210	204	208	192	180	175
6	Protococcus	55	48	50	50	65	88	85	88	80	70	68	50
7	Actinastrum	28	30	34	38	48	65	89	80	72	64	60	54
8	Scnedesmus	30	32	30	39	45	50	56	68	70	72	70	65
	Total	**300**	**323**	**307**	**354**	**358**	**450**	**497**	**476**	**456**	**451**	**406**	**359**
Bacillariophyceae													
1	Navicula	45	30	45	68	70	84	89	75	70	64	59	50
2	Frustulia	0	8	9	0	10	18	29	20	19	24	20	18
3	Synedra	28	35	30	45	67	68	65	40	46	40	25	20
4	Diatoma	19	20	19	36	37	40	44	48	39	35	38	25
	Total	**92**	**93**	**103**	**149**	**184**	**210**	**227**	**183**	**174**	**163**	**142**	**113**
Myxophyceae													
1	Microcystis	180	200	190	198	220	240	238	220	215	202	200	190
2	Tetraspedia	0	20	20	10	0	0	28	26	29	25	20	25
3	Anabaena	0	0	0	0	24	30	35	20	17	10	15	0
4	Oscillatoria	10	0	0	0	24	45	49	30	25	20	18	15
	Total	**190**	**220**	**210**	**208**	**268**	**315**	**350**	**296**	**286**	**257**	**253**	**230**
	Grand Total	**582**	**636**	**620**	**711**	**810**	**975**	**1074**	**955**	**916**	**871**	**801**	**702**

Table- 14

Monthly Variation of Phytoplankton

Station-C

Period : 2001-2002

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Chlorophyceae													
1	Coelastrum	20	22	10	14	0	0	0	9	7	5	0	0
2	Spirogyra	10	16	0	0	0	0	0	12	0	14	9	7
3	Zygnema	16	19	20	22	0	32	35	25	19	18	10	19
4	Ulothrix	20	22	24	30	28	35	38	0	0	16	10	0
5	Tetraspora	110	122	140	165	170	182	210	211	209	180	173	160
6	Protococcus	45	40	43	63	67	78	85	80	79	70	60	52
7	Actinastrum	25	29	35	38	52	60	83	78	79	60	53	58
8	Scnedesmus	27	30	35	38	45	50	58	66	69	75	78	70
	Total	**273**	**300**	**307**	**370**	**362**	**437**	**509**	**481**	**462**	**438**	**393**	**366**
Bacillariophyceae													
1	Navicula	42	30	48	72	77	80	90	77	71	60	59	50
2	Frustulia	0	8	7	0	10	18	28	22	20	18	19	16
3	Synedra	28	30	29	45	63	68	65	40	44	40	25	20
4	Diatoma	18	14	19	30	38	40	45	49	39	38	35	30
	Total	**88**	**82**	**103**	**147**	**188**	**206**	**228**	**188**	**174**	**156**	**138**	**116**
Myxophyceae													
1	Microcystis	180	200	193	208	220	233	250	245	190	181	170	181
2	Tetraspedia	0	20	20	10	0	0	30	28	25	20	18	20
3	Anabaena	0	0	0	0	24	30	35	19	20	7	9	0
4	Oscillatoria	10	0	0	0	25	38	45	26	25	20	18	16
	Total	**190**	**220**	**213**	**218**	**269**	**301**	**360**	**318**	**260**	**228**	**215**	**217**
	Grand Total	**551**	**602**	**623**	**735**	**819**	**944**	**1097**	**987**	**896**	**822**	**746**	**699**

Table- 15

Monthly Variation of Phytoplankton

Station-D

Period : 2001-2002

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Chlorophyceae													
1	Coelastrum	13	10	11	14	0	0	0	8	9	6	0	0
2	Spirogyra	6	8	0	0	0	0	0	9	0	8	7	6
3	Zygnema	13	14	15	18	0	30	22	16	19	14	8	7
4	Ulothrix	15	17	20	23	25	30	35	0	0	16	18	0
5	Tetraspora	130	138	150	160	178	175	215	209	210	200	190	195
6	Protococcus	50	48	53	52	67	90	88	89	80	73	65	55
7	Actinastrum	25	29	30	38	40	55	82	78	75	65	70	64
8	Scnedesmus	30	28	33	39	45	53	58	68	71	75	73	70
	Total	**282**	**292**	**312**	**344**	**355**	**433**	**500**	**477**	**464**	**457**	**431**	**397**
Bacillariophyceae													
1	Navicula	35	30	47	70	78	82	90	76	72	64	59	60
2	Frustulia	0	7	8	0	10	16	28	25	24	20	19	18
3	Synedra	28	33	29	45	66	64	68	40	43	44	25	26
4	Diatoma	18	15	16	32	37	40	45	48	42	39	30	33
	Total	**81**	**85**	**100**	**147**	**191**	**202**	**231**	**189**	**181**	**167**	**133**	**137**
Myxophyceae													
1	Microcystis	183	190	181	200	200	208	220	233	240	240	163	168
2	Tetraspedia	0	25	20	13	0	0	29	30	25	20	19	24
3	Anabaena	0	0	0	0	24	30	35	18	19	10	8	0
4	Oscillatoria	8	0	0	0	20	43	50	30	27	24	20	24
	Total	**191**	**215**	**201**	**213**	**244**	**281**	**334**	**311**	**311**	**294**	**210**	**216**
	Grand Total	**554**	**592**	**613**	**704**	**790**	**916**	**1065**	**977**	**956**	**918**	**774**	**750**

Table- 16

Monthly Variation of Phytoplankton

Station-A

Period : 2002-2003

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Chlorophyceae													
1	Coelastrum	20	18	17	19	0	0	0	15	10	9	0	0
2	Spirogyra	10	14	0	0	0	0	0	9	0	12	10	15
3	Zygnema	15	18	20	25	0	30	27	18	19	20	19	14
4	Ulothrix	20	19	20	25	28	33	38	0	0	18	10	0
5	Tetraspora	130	142	149	165	178	190	220	225	210	200	190	185
6	Protococcus	60	48	50	58	68	89	88	90	79	78	67	58
7	Actinastrum	30	34	30	47	49	64	88	84	74	65	59	58
8	Scnedesmus	30	29	34	46	48	51	58	70	79	78	77	75
	Total	**315**	**322**	**320**	**385**	**371**	**457**	**519**	**511**	**471**	**480**	**432**	**405**
Bacillariophyceae													
1	Navicula	48	34	48	75	79	88	90	79	72	68	64	57
2	Frustulia	0	8	9	0	14	20	30	34	27	24	25	19
3	Synedra	30	39	35	44	68	70	68	44	48	45	24	27
4	Diatoma	21	18	19	35	39	44	44	49	44	39	39	28
	Total	**99**	**99**	**111**	**154**	**200**	**222**	**232**	**206**	**191**	**176**	**152**	**131**
Myxophyceae													
1	Microcystis	190	208	210	220	220	235	245	250	259	200	190	175
2	Tetraspedia	0	28	20	16	0	0	32	28	25	29	27	27
3	Anabaena	0	0	0	0	25	30	38	19	18	10	15	0
4	Oscillatoria	10	0	0	0	27	44	50	33	28	27	24	20
	Total	**200**	**236**	**230**	**236**	**272**	**309**	**365**	**330**	**330**	**266**	**256**	**222**
	Grand Total	**614**	**657**	**661**	**775**	**843**	**988**	**1116**	**1047**	**992**	**922**	**840**	**758**

Table- 17

Monthly Variation of Phytoplankton

Station-B **Period : 2002-2003**

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Chlorophyceae													
1	Coelastrum	25	22	20	24	0	0	0	23	18	10	0	0
2	Spirogyra	15	18	0	0	0	0	0	12	0	15	10	18
3	Zygnema	19	24	26	30	0	38	28	24	20	24	20	18
4	Ulothrix	24	27	26	28	34	37	40	0	0	22	12	0
5	Tetraspora	135	145	152	170	183	195	230	230	220	200	185	198
6	Protococcus	65	50	55	59	75	90	97	100	80	72	75	59
7	Actinastrum	35	38	37	48	54	68	94	80	75	62	55	56
8	Scnedesmus	28	26	30	44	49	55	61	59	83	80	79	76
	Total	346	350	346	403	395	483	550	528	496	485	436	425
Bacillariophyceae													
1	Navicula	50	33	50	79	85	93	96	100	74	69	60	55
2	Frustulia	0	10	12	0	16	24	35	40	27	29	25	20
3	Synedra	33	40	39	47	70	74	70	45	50	49	27	29
4	Diatoma	25	20	23	38	40	46	49	48	40	45	42	35
	Total	**108**	**103**	**124**	**164**	**211**	**237**	**250**	**233**	**191**	**192**	**154**	**139**
Myxophyceae													
1	Microcystis	180	200	208	210	209	230	235	238	245	200	210	180
2	Tetraspedia	0	34	24	30	0	0	38	30	27	35	28	29
3	Anabaena	0	0	0	0	26	34	40	20	25	15	19	0
4	Oscillatoria	10	0	0	0	25	48	55	39	28	25	28	33
	Total	**190**	**234**	**232**	**240**	**260**	**312**	**368**	**327**	**325**	**275**	**285**	**242**
	Grand Total	**644**	**687**	**702**	**807**	**866**	**1032**	**1168**	**1088**	**1012**	**952**	**875**	**806**

Table- 18

Monthly Variation of Phytoplankton

Station-C

Period : 2002-2003

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Chlorophyceae													
1	Coelastrum	22	20	18	20	0	0	0	18	8	7	0	0
2	Spirogyra	14	16	0	0	0	0	0	12	0	15	12	19
3	Zygnema	17	20	23	24	0	34	28	20	22	24	19	16
4	Ulothrix	24	20	25	28	30	36	40	0	0	22	14	0
5	Tetraspora	143	150	163	170	180	225	230	220	190	183	180	174
6	Protococcus	62	50	56	71	78	90	88	98	80	88	68	59
7	Actinastrum	34	38	35	49	50	68	88	90	85	68	60	70
8	Scnedesmus	36	30	39	48	54	56	64	78	80	85	79	80
	Total	**352**	**344**	**359**	**410**	**392**	**509**	**538**	**536**	**465**	**492**	**432**	**418**
Bacillariophyceae													
1	Navicula	50	38	50	78	80	90	102	75	70	65	63	56
2	Frustulia	0	10	11	0	19	24	33	36	28	29	39	20
3	Synedra	38	40	45	50	70	78	70	48	50	49	30	32
4	Diatoma	22	20	25	38	40	47	48	55	50	40	45	30
	Total	**110**	**108**	**131**	**166**	**209**	**239**	**253**	**214**	**198**	**183**	**177**	**138**
Myxophyceae													
1	Microcystis	200	206	215	210	215	230	240	260	250	200	180	170
2	Tetraspedia	0	30	28	19	0	0	30	27	26	30	28	30
3	Anabaena	0	0	0	0	27	30	40	20	22	15	18	0
4	Oscillatoria	15	0	0	0	30	45	55	35	30	28	25	18
	Total	**215**	**236**	**243**	**229**	**272**	**305**	**365**	**342**	**328**	**273**	**251**	**218**
	Grand Total	**677**	**688**	**733**	**805**	**873**	**1053**	**1156**	**1092**	**991**	**948**	**860**	**774**

Table- 19

Monthly Variation of Phytoplankton

Station-D

Period : 2002-2003

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Chlorophyceae													
1	Coelastrum	28	25	24	30	0	0	0	28	20	15	0	0
2	Spirogyra	16	20	0	0	0	0	0	20	0	22	12	20
3	Zygnema	20	27	28	34	0	40	30	28	30	29	20	19
4	Ulothrix	30	26	25	30	36	38	42	0	0	25	15	0
5	Tetraspora	145	153	161	173	185	238	233	225	200	190	185	180
6	Protococcus	68	50	56	65	78	100	120	100	90	78	70	65
7	Actinastrum	38	40	39	50	55	70	100	80	60	65	62	70
8	Scnedesmus	30	25	29	39	50	63	63	59	90	85	78	75
	Total	**375**	**366**	**362**	**421**	**404**	**549**	**588**	**540**	**490**	**509**	**442**	**429**
Bacillariophyceae													
1	Navicula	55	38	60	82	88	95	100	110	78	69	64	60
2	Frustulia	0	15	17	0	18	28	40	45	30	35	28	24
3	Synedra	35	45	40	48	75	79	72	48	55	50	28	32
4	Diatoma	27	25	24	40	45	48	54	55	44	46	40	34
	Total	**117**	**123**	**141**	**170**	**226**	**250**	**266**	**258**	**207**	**200**	**160**	**150**
Myxophyceae													
1	Microcystis	180	200	210	215	218	234	240	245	250	200	215	190
2	Tetraspedia	0	33	25	33	0	0	40	38	28	38	30	32
3	Anabaena	0	0	0	0	27	36	45	24	27	19	22	0
4	Oscillatoria	15	0	0	0	28	50	60	40	30	35	33	38
	Total	**195**	**233**	**235**	**248**	**273**	**320**	**385**	**347**	**335**	**292**	**300**	**260**
	Grand Total	**687**	**722**	**738**	**839**	**903**	**1119**	**1239**	**1145**	**1032**	**1001**	**902**	**839**

Table- 20

Monthly Variation of Zooplankton

Station-A **Period : 2001-2002**

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Protozoa													
1	Paramecium	8	7	9	10	11	13	12	9	8	7	6	7
2	Euglena	11	13	15	14	15	17	19	12	13	18	13	12
3	Euglypha	6	5	10	12	13	18	22	20	0	0	9	10
4	Vorticella	8	9	12	15	16	20	21	0	0	5	4	9
	Total	**33**	**34**	**46**	**51**	**55**	**68**	**74**	**41**	**21**	**30**	**32**	**38**
Rotifera													
1	Brachionus	9	10	12	15	19	25	32	30	29	27	19	18
2	Filinia	6	0	8	10	11	12	29	17	18	21	15	14
3	Keretella	0	0	0	0	0	0	17	8	7	10	11	8
4	Testudinella	0	0	0	0	10	14	21	15	14	18	20	16
5	Asplanchna	6	9	11	15	17	21	25	27	25	23	22	20
6	Philodina	8	10	12	0	14	16	20	22	19	18	20	19
	Total	**29**	**29**	**43**	**40**	**71**	**88**	**144**	**119**	**112**	**117**	**107**	**95**
Crustacea													
(a)	**Copepoda**												
1	Cyclops	9	10	11	13	20	22	28	26	19	17	15	12
2	Mesocyclops	0	0	0	0	0	0	0	10	12	11	9	8
3	Eggs & Nauplii	14	16	18	30	34	38	40	39	36	32	32	30
4	Diaptomus	7	9	10	11	14	16	18	15	13	14	10	9
	Total	**30**	**35**	**39**	**54**	**68**	**76**	**86**	**90**	**80**	**74**	**66**	**59**
(b)	**Cladocerans**												
1	Daphnia	8	9	12	15	17	19	25	21	0	0	0	7
2	Ceriodaphnia	0	0	0	0	19	20	32	34	29	26	17	16
3	Alonella	8	10	8	13	15	19	24	20	18	20	21	20
	Total	**16**	**19**	**20**	**28**	**51**	**58**	**81**	**75**	**47**	**46**	**38**	**43**
	Grand Total	**108**	**117**	**148**	**173**	**245**	**290**	**385**	**325**	**260**	**267**	**243**	**235**

Table- 21

Monthly Variation of Zooplankton

Station-B

Period : 2001-2002

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Protozoa													
1	Paramecium	7	8	10	11	13	14	16	10	9	8	9	10
2	Euglena	10	12	14	10	16	17	19	15	11	15	14	11
3	Euglypha	5	4	11	13	15	19	20	20	0	0	8	10
4	Vorticella	7	8	12	14	16	22	25	0	0	9	8	7
	Total	**29**	**32**	**47**	**48**	**60**	**72**	**80**	**45**	**20**	**32**	**39**	**38**
Rotifera													
1	Brachionus	10	12	11	15	20	28	35	33	32	28	26	28
2	Filinia	7	0	9	12	13	15	30	18	18	20	16	15
3	Keretella	0	0	0	0	0	0	18	9	8	10	12	9
4	Testudinella	0	0	0	0	10	15	22	16	18	19	22	17
5	Philodina	10	12	15	0	16	18	20	19	20	21	20	18
6	Asplanchna	7	9	12	16	19	20	28	26	23	22	21	20
	Total	**34**	**33**	**47**	**43**	**78**	**96**	**153**	**121**	**119**	**120**	**117**	**107**
Crustacea													
(a)	**Copepoda**												
1	Cyclops	8	10	12	14	19	21	29	27	19	20	18	16
2	Mesocyclops	0	0	0	0	0	0	0	12	13	19	10	11
3	Eggs & Nauplii	15	17	18	26	36	39	42	40	34	30	29	34
4	Diaptomus	10	12	13	17	15	18	49	20	16	14	12	10
	Total	**33**	**39**	**43**	**57**	**70**	**78**	**120**	**99**	**82**	**83**	**69**	**71**
(b)	**Cladocerans**												
1	Daphnia	10	11	13	13	18	20	24	23	0	0	0	10
2	Ceriodaphnia	0	0	0	0	20	19	30	29	27	25	21	19
3	Alonella	8	10	12	15	16	20	23	20	19	22	20	18
	Total	**18**	**21**	**25**	**28**	**54**	**59**	**77**	**72**	**46**	**47**	**41**	**47**
	Grand Total	**114**	**125**	**162**	**176**	**262**	**305**	**430**	**337**	**267**	**282**	**266**	**263**

Table- 22

Monthly Variation of Zooplankton

Station-C **Period : 2001-2002**

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Protozoa													
1	Paramecium	6	9	11	13	13	15	17	9	8	10	11	9
2	Euglena	11	13	15	9	16	14	18	14	10	13	12	10
3	Euglypha	6	3	10	12	15	17	20	19	0	0	7	9
4	Vorticella	7	6	13	10	17	20	22	0	0	10	11	13
5	Arcella	9	10	11	12	15	16	20	0	0	9	10	12
	Total	**39**	**41**	**60**	**56**	**76**	**82**	**97**	**42**	**18**	**42**	**51**	**53**
Rotifera													
1	Brachionus	10	13	10	14	22	27	30	31	29	27	25	26
2	Filinia	9	0	11	13	13	17	28	21	19	20	16	17
3	Keretella	0	0	0	0	0	0	19	10	9	12	13	10
4	Testudinella	0	0	0	0	0	14	20	17	19	20	20	18
5	Philodina	10	13	16	0	0	20	22	18	20	23	17	19
6	Asplanchna	8	10	11	15	15	21	26	25	20	21	18	20
	Total	**37**	**36**	**48**	**42**	**50**	**99**	**145**	**122**	**116**	**123**	**109**	**110**
Crustacea													
(a)	**Copepoda**												
1	Cyclops	9	11	12	15	18	20	30	28	16	20	19	18
2	Mesocyclops	0	0	0	0	0	0	0	14	15	20	12	13
3	Eggs & Nauplii	16	18	20	25	35	40	41	38	31	30	27	33
4	Diaptomus	9	11	14	15	14	20	21	20	17	18	16	14
	Total	**34**	**40**	**46**	**55**	**67**	**80**	**92**	**100**	**79**	**88**	**74**	**78**
(b)	**Cladocerans**												
1	Daphnia	12	13	14	12	20	22	25	20	0	0	0	0
2	Ceriodaphnia	0	0	0	0	21	18	24	27	26	24	20	18
3	Alonella	10	12	13	15	18	20	25	20	18	24	22	17
	Total	**22**	**25**	**27**	**27**	**59**	**60**	**74**	**67**	**44**	**48**	**42**	**35**
	Grand Total	**132**	**142**	**181**	**180**	**252**	**321**	**408**	**331**	**257**	**301**	**276**	**276**

Table- 23

Monthly Variation of Zooplankton

Station-D **Period : 2001-2002**

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Protozoa													
1	Paramecium	7	6	8	10	12	14	16	11	10	8	10	9
2	Euglena	10	12	14	13	13	16	20	10	12	16	11	10
3	Euglypha	5	4	8	11	12	16	20	19	0	0	10	9
4	Vorticella	7	8	10	14	10	15	18	0	0	8	12	11
5	Euglypha	5	6	12	13	14	17	20	21	0	0	8	10
	Total	**34**	**36**	**52**	**61**	**61**	**78**	**94**	**61**	**22**	**32**	**51**	**49**
Rotifera													
1	Brachionus	8	11	12	14	16	23	30	28	26	24	18	16
2	Filinia	5	0	6	8	12	13	28	19	17	20	14	13
3	Keretella	0	0	0	0	0	0	18	9	6	12	13	10
4	Testudinella	0	0	0	0	10	15	20	16	14	19	21	17
5	Philodina	10	11	11	0	15	12	19	20	21	17	20	18
6	Asplanchna	7	10	12	14	16	20	23	24	22	20	22	21
	Total	**30**	**32**	**41**	**36**	**69**	**83**	**138**	**116**	**106**	**112**	**108**	**95**
Crustacea													
(a)	**Copepoda**												
1	Cyclops	10	12	13	15	19	20	25	24	19	18	16	13
2	Mesocyclops	0	0	0	0	0	0	0	12	14	10	8	10
3	Eggs & Nauplii	13	15	16	27	32	35	38	27	36	30	28	27
4	Diaptomus	6	10	12	11	13	15	19	17	14	16	11	8
	Total	**29**	**37**	**41**	**53**	**64**	**70**	**82**	**80**	**83**	**74**	**63**	**58**
(b)	**Cladocerans**												
1	Daphnia	10	11	13	14	16	20	24	22	0	0	0	8
2	Ceriodaphnia	0	0	0	0	20	22	34	35	28	26	18	19
3	Alonella	10	12	7	12	14	20	22	20	19	20	22	18
	Total	**20**	**23**	**20**	**26**	**50**	**62**	**80**	**77**	**47**	**46**	**40**	**45**
	Grand Total	**113**	**128**	**154**	**176**	**244**	**293**	**394**	**334**	**258**	**264**	**262**	**247**

Table- 24

Monthly Variation of Zooplankton

Station-A **Period : 2002-2003**

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Protozoa													
1	Paramecium	10	9	11	13	15	14	17	16	18	17	17	13
2	Euglena	12	14	16	15	14	18	20	14	16	18	14	12
3	Euglypha	9	10	13	14	17	22	24	0	0	8	6	9
4	Vorticella	8	10	12	13	15	18	20	0	0	10	12	11
5	Euglypha	5	7	10	14	13	19	20	18	18	0	9	12
	Total	**44**	**50**	**62**	**69**	**74**	**91**	**101**	**48**	**52**	**53**	**58**	**57**
Rotifera													
1	Brachionus	9	12	12	13	15	22	28	27	26	27	19	15
2	Filinia	7	0	5	9	12	14	26	17	18	20	12	13
3	Keretella	0	0	0	0	0	0	18	8	7	15	20	10
4	Testudinella	0	0	0	0	9	14	20	15	16	19	22	19
5	Philodina	11	12	14	0	16	14	2	22	23	18	20	16
6	Asplanchna	7	11	12	14	16	20	24	25	22	20	27	20
	Total	**34**	**35**	**43**	**36**	**68**	**84**	**118**	**114**	**112**	**119**	**120**	**93**
Crustacea													
(a)	**Copepoda**												
1	Cyclops	10	11	14	16	20	22	28	27	20	19	18	15
2	Mesocyclops	0	0	0	0	0	0	0	13	15	10	9	10
3	Eggs & Nauplii	14	15	17	28	30	34	37	25	32	30	26	25
4	Diaptomus	7	10	13	10	12	14	20	16	15	17	16	9
	Total	**31**	**36**	**44**	**54**	**62**	**70**	**85**	**81**	**82**	**76**	**69**	**59**
(b)	**Cladocerans**												
1	Daphnia	11	12	14	15	17	20	23	21	0	0	0	9
2	Ceriodaphnia	0	0	0	0	19	20	32	34	27	26	18	19
3	Alonella	10	11	8	12	14	20	25	20	19	18	20	17
	Total	**21**	**23**	**22**	**27**	**50**	**60**	**80**	**75**	**46**	**44**	**38**	**45**
	Grand Total	**130**	**144**	**171**	**186**	**254**	**305**	**384**	**318**	**292**	**292**	**285**	**254**

Table- 25

Monthly Variation of Zooplankton

Station-B **Period : 2002-2003**

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Protozoa													
1	Paramecium	8	6	11	12	14	15	18	13	10	9	8	7
2	Euglena	10	11	13	10	13	17	20	12	11	14	13	10
3	Euglypha	8	9	10	14	15	20	27	0	0	8	10	9
4	Vorticella	10	11	13	12	16	17	20	0	0	9	7	12
5	Euglypha	6	7	13	14	16	19	22	20	0	0	10	12
	Total	**42**	**44**	**60**	**62**	**74**	**88**	**107**	**45**	**21**	**40**	**48**	**50**
Rotifera													
1	Brachionus	11	14	10	16	22	27	33	30	28	26	25	23
2	Filinia	8	0	11	13	14	15	32	19	18	22	15	14
3	Keretella	0	0	0	0	0	0	17	8	7	10	13	9
4	Testudinella	0	0	0	0	9	14	20	15	17	20	20	16
5	Philodina	8	10	14	0	17	18	22	17	20	20	18	17
6	Asplanchna	8	11	15	17	20	22	27	25	22	20	23	19
	Total	**35**	**35**	**50**	**46**	**82**	**96**	**151**	**114**	**112**	**118**	**114**	**98**
Crustacea													
(a)	**Copepoda**												
1	Cyclops	6	8	10	15	20	17	27	25	18	16	17	15
2	Mesocyclops	0	0	0	0	0	0	0	10	14	20	12	10
3	Eggs & Nauplii	16	18	20	25	35	40	40	37	35	28	27	30
4	Diaptomus	10	12	14	15	14	19	20	22	15	16	12	13
	Total	**32**	**38**	**44**	**55**	**69**	**76**	**87**	**94**	**82**	**80**	**68**	**68**
(b)	**Cladocerans**												
1	Daphnia	8	12	13	14	20	22	25	22	0	0	0	8
2	Ceriodaphnia	0	0	0	0	18	19	27	28	26	25	20	18
3	Alonella	10	12	13	12	17	20	24	20	21	23	19	18
	Total	**18**	**24**	**26**	**26**	**55**	**61**	**76**	**70**	**47**	**48**	**39**	**44**
	Grand Total	**127**	**141**	**180**	**189**	**280**	**321**	**421**	**323**	**262**	**286**	**269**	**260**

Table- 26
Monthly Variation of Zooplankton

Station-C **Period : 2002-2003**

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Protozoa													
1	Paramecium	5	10	13	13	15	17	19	10	9	12	16	17
2	Euglena	10	14	15	10	16	13	18	12	10	12	11	9
3	Euglypha	5	4	12	14	17	18	19	0	0	9	10	12
4	Vorticella	7	8	12	14	18	22	24	0	0	10	14	13
5	Euglypha	6	10	11	13	14	20	22	19	0	0	10	14
	Total	**33**	**46**	**63**	**64**	**80**	**90**	**102**	**41**	**19**	**43**	**61**	**65**
Rotifera													
1	Brachionus	10	13	14	16	22	28	30	32	27	29	20	18
2	Filinia	8	0	8	10	14	18	25	19	20	21	12	16
3	Keretella	0	0	0	0	0	0	20	9	6	16	22	12
4	Testudinella	0	0	0	0	10	15	22	18	17	20	20	16
5	Philodina	10	12	15	0	18	14	20	21	22	19	17	18
6	Asplanchna	8	12	14	15	18	19	25	28	20	19	26	19
	Total	**36**	**37**	**51**	**41**	**82**	**94**	**142**	**127**	**112**	**124**	**117**	**99**
Crustacea													
(a)	**Copepoda**												
1	Cyclops	11	12	15	18	22	26	28	27	20	19	20	18
2	Mesocyclops	0	0	0	0	0	0	0	14	16	10	8	12
3	Eggs & Nauplii	15	16	18	30	32	31	35	24	30	24	20	18
4	Diaptomus	8	9	14	13	15	16	17	20	16	18	17	10
	Total	**34**	**37**	**47**	**61**	**69**	**73**	**80**	**85**	**82**	**71**	**65**	**58**
(b)	**Cladocerans**												
1	Daphnia	10	12	16	19	20	22	25	20	0	0	0	0
2	Ceriodaphnia	0	0	0	0	18	20	35	30	28	26	19	20
3	Alonella	10	12	9	14	15	24	27	26	18	20	22	18
	Total	**20**	**24**	**25**	**33**	**53**	**66**	**87**	**76**	**46**	**46**	**41**	**38**
	Grand Total	**123**	**144**	**186**	**199**	**284**	**323**	**411**	**329**	**259**	**284**	**284**	**260**

Table- 27

Monthly Variation of Zooplankton

Station-D **Period : 2002-2003**

S. No.		Dec	Jan.	Feb.	March	April	May	June	July	Aug.	Sept	Oct.	Nov.
Protozoa													
1	Paramecium	9	8	10	12	16	19	20	10	11	9	10	13
2	Euglena	12	10	12	13	14	18	22	12	14	17	12	11
3	Euglypha	6	7	10	12	13	16	25	20	0	0	10	12
4	Vorticella	8	9	12	15	10	16	19	0	0	12	13	12
5	Euglypha	6	10	13	15	15	16	20	22	0	0	9	11
	Total	**41**	**44**	**57**	**67**	**68**	**85**	**106**	**64**	**25**	**38**	**54**	**59**
Rotifera													
1	Brachionus	9	13	14	16	19	22	28	25	22	25	17	19
2	Filinia	6	0	8	10	14	15	30	20	16	22	15	14
3	Keretella	0	0	0	0	0	0	20	10	8	13	16	18
4	Testudinella	0	0	0	0	12	16	22	18	15	20	22	20
5	Philodina	12	12	13	0	16	18	20	22	22	19	20	19
6	Asplanchna	8	10	14	15	18	20	25	20	20	18	20	21
	Total	**35**	**35**	**49**	**41**	**79**	**91**	**145**	**115**	**103**	**117**	**110**	**111**
Crustacea													
(a)	**Copepoda**												
1	Cyclops	12	13	14	16	20	24	25	26	20	19	17	14
2	Mesocyclops	0	0	0	0	0	0	0	14	16	12	9	10
3	Eggs & Nauplii	12	16	18	26	30	34	34	25	35	28	29	26
4	Diaptomus	7	10	13	10	14	16	20	19	14	15	10	9
	Total	**31**	**39**	**45**	**52**	**64**	**74**	**79**	**84**	**85**	**74**	**65**	**59**
(b)	**Cladocerans**												
1	Daphnia	12	13	14	18	17	25	20	23	0	0	0	9
2	Ceriodaphnia	0	0	0	0	20	25	35	36	28	27	19	20
3	Alonella	12	13	8	12	15	20	23	22	20	22	23	19
	Total	**24**	**26**	**22**	**30**	**52**	**70**	**78**	**81**	**48**	**49**	**42**	**48**
	Grand Total	**131**	**144**	**173**	**190**	**263**	**320**	**408**	**344**	**261**	**278**	**271**	**277**

Table-28

List of Fishes

1- Labeo rohita

2- Labeo calbasu

3- Catla catla

4- Cirrihinus mrigala

5- Wallago attu

6- Heteropneustes fosilis

7- Chanda nama

8- Chanda ranga

9- Mystus seenghala

10- Clarius batrachus

11- Notopterus chitala

12- Chana marulius

Table-29

Seasnal Variation of Chemical Factors of Keerat Sagar Soil

Period 2001-2002

Months	pH	Phosphorus (Po4)	Potassium (K)	Nitrogen (N)	Season
November	8.4	H	MH	H	Winter
December	8.6	H	M	M	
January	8.5	H	M	H	
February	8.3	MH	MH	H	
March	8.1	H	H	H	Summer
April	8	L	H	H	
May	8.5	M	M	H	
June	8.3	MH	M	H	
July	8.1	MH	MH	M	Rainy
August	8.0	H	L	VL	
September	8.1	MH	L	VL	
October	8.2	MH	M	H	

MH. =Medium High
M = Medium
H. = High,
VL = Very Low
L. =Low
MVL = Medium Very Low

Table-30

Seasnal Variation of Chemical Factors of Keerat Sagar Soil

Period 2002-2003

Months	pH.	Phosphorus (Po4)	Potassium (K)	Nitrogen (N)	Season
November	8.1	MH	M	VL	Winter
December	8.3	MH	M	VL	
January	8.4	H	MH	L	
February	8.2	L	H	M	
March	8.1	L	H	M	Summer
April	8.2	M	M	H	
May	8.1	L	H	H	
June	8.1	M	M	H	
July	8.0	M	M	VL	Rainy
August	8.1	MH	MH	VL	
September	8.3	H	L	MVL	
October	8.1	MH	M	M	

MH. =Medium High
M = Medium
H. = High,
VL = Very Low
L. =Low
MVL = Medium Very Low

Table 31

Statistical Values of Keerat Sagar Station-A

S.No.	Perameter	2001-2002				2002-2003				Total			
		Mean	Std. Dev.	Max.	Min	Mean	Std. Dev.	Max.	Min	Mean	Std. Dev.	Max.	Min
1	Temperature	27.04	3.98	32.40	20.80	24.30	5.42	31.30	15.60	25.67	4.70	31.85	18.20
2	Turbidity	29.20	14.61	61.10	14.02	30.37	16.03	65.50	16.20	29.78	15.32	63.30	15.11
3	Hydrogen-ion-concentration	7.99	0.21	8.30	7.60	7.98	0.21	8.20	7.50	7.98	0.21	82.50	7.55
4	Carbonate	10.65	3.10	16.00	6.70	10.98	3.15	16.40	6.75	10.81	3.12	16.20	6.72
5	Bicarbonate	160.66	18.65	187.30	136.30	162.10	18.44	198.20	138.40	161.38	18.54	197.40	136.25
6	Total Alkalinity	171.38	36.01	197.50	147.80	173.85	17.49	200.70	148.40	172.61	26.79	199.10	148.10
7	Chloride	27.50	9.24	45.00	10.00	28.13	8.85	42.70	11.20	27.81	9.04	44.15	10.60
8	Ammonical nitrogen	0.51	0.15	0.78	0.28	0.44	0.14	0.72	0.30	0.47	0.14	0.75	0.29
9	Phosphate	0.45	0.15	0.70	0.21	0.37	0.16	0.68	0.26	0.41	0.14	0.69	0.23
10	Dissolved oxygen	5.85	1.34	7.50	3.50	6.43	1.36	8.40	4.10	6.14	1.35	7.95	3.80
11	Carbon-di-oxide	14.24	3.80	20.20	8.90	14.99	4.21	20.90	8.50	14.61	4.00	20.20	8.70

Table 32

Statistical Values of Keerat Sagar Station-B

S.No.	Perameter	2001-2002				2002-2003				Total			
		Mean	Std. Dev.	Max.	Min	Mean	Std. Dev.	Max.	Min	Mean	Std. Dev.	Max.	Min
1	Temperature	26.20	3.86	32.00	20.00	24.07	5.60	32.50	15.60	25.13	4.73	32.25	17.80
2	Turbidity	29.09	14.71	62.00	14.50	31.28	16.62	69.20	16.80	28.68	15.66	65.60	15.65
3	Hydrogen-ion-concentration	7.69	0.16	8.00	7.50	7.86	0.22	8.10	7.50	7.77	0.19	8.05	7.50
4	Carbonate	10.99	3.32	17.40	5.80	11.08	2.93	15.26	6.98	11.03	3.12	16.33	6.39
5	Bicarbonate	169.34	17.68	193.20	141.20	167.21	17.55	195.40	144.80	168.28	17.61	194.30	143.00
6	Total Alkalinity	176.32	16.08	205.00	154.20	178.30	16.46	206.50	155.10	177.31	16.27	205.75	154.65
7	Chloride	28.26	9.36	46.00	10.80	28.51	8.80	43.50	11.80	28.38	9.08	44.75	11.30
8	Ammonical nitrogen	0.52	0.14	0.79	0.35	0.54	0.14	0.80	0.38	0.53	0.14	0.79	0.36
9	Phosphate	0.46	0.15	0.72	0.30	0.48	0.16	0.73	0.30	0.47	0.15	0.72	0.30
10	Dissolved oxygen	5.72	1.33	7.40	3.38	6.36	1.34	8.15	3.75	6.05	1.33	7.77	3.56
11	Carbon-di-oxide	15.55	4.13	21.80	8.10	16.16	4.61	22.40	8.12	15.85	4.37	22.10	8.11

Table 33

Statistical Values of Keerat Sagar Station-C

S.No.	Perameter	2001-2002				2002-2003				Total			
		Mean	Std. Dev.	Max.	Min	Mean	Std. Dev.	Max.	Min	Mean	Std. Dev.	Max.	Min
1	Temperature	26.24	3.75	31.80	20.40	24.64	5.72	32.50	15.60	25.44	4.76	32.15	18.00
2	Turbidity	29.94	14.61	61.93	15.00	31.81	16.67	69.20	16.80	30.87	15.64	65.56	15.90
3	Hydrogen-ion-concentration	7.68	0.14	7.90	7.50	7.84	0.18	8.10	7.50	7.76	0.16	8.00	7.50
4	Carbonate	10.90	3.44	17.50	6.50	11.31	2.69	15.26	6.94	11.10	3.06	16.38	6.74
5	Bicarbonate	168.50	17.63	196.30	144.50	170.05	17.87	198.50	147.80	169.28	17.75	197.40	146.15
6	Total Alkalinity	179.40	15.78	208.18	157.90	181.35	16.88	210.48	158.80	180.38	16.33	209.64	158.35
7	Chloride	28.42	9.35	46.05	11.00	28.77	8.90	43.50	11.80	28.59	9.12	44.77	11.40
8	Ammonical nitrogen	0.46	0.14	0.72	0.32	0.48	0.14	0.73	0.30	0.47	0.14	0.73	0.31
9	Phosphate	0.54	0.13	0.80	0.39	0.55	0.15	0.80	0.38	0.54	0.14	0.80	0.38
10	Dissolved oxygen	5.77	1.33	7.45	3.40	6.26	1.42	8.15	3.75	6.01	1.37	7.80	3.57
11	Carbon-di-oxide	16.23	4.58	22.70	8.12	16.84	4.85	22.40	8.12	16.54	4.71	22.55	8.12

Table 34

Statistical Values of Keerat Sagar Station-D

S.No.	Perameter	2001-2002				2002-2003				Total			
		Mean	Std. Dev.	Max.	Min	Mean	Std. Dev.	Max.	Min	Mean	Std. Dev.	Max.	Min
1	Temperature	26.24	3.75	31.80	20.40	24.64	5.72	32.50	15.60	25.44	4.76	32.15	18.00
2	Turbidity	29.94	14.61	61.93	15.00	31.81	16.67	69.20	16.80	30.87	15.64	65.56	15.90
3	Hydrogen-ion-concentration	7.68	0.14	7.90	7.50	7.84	0.18	8.10	7.50	7.76	0.16	8.00	7.50
4	Carbonate	10.90	3.44	17.50	6.50	11.31	2.69	15.26	6.98	11.10	3.06	16.38	6.74
5	Bicarbonate	161.48	18.26	189.40	138.40	160.54	17.90	188.70	136.20	161.10	18.08	189.05	167.30
6	Total Alkalinity	172.15	17.78	201.40	148.80	171.80	16.53	198.86	147.20	171.95	17.15	200.13	148.00
7	Chloride	28.42	9.35	46.05	11.00	28.77	8.90	43.50	11.80	28.59	9.12	44.77	11.40
8	Ammonical nitrogen	0.54	0.13	0.80	0.39	0.55	0.14	0.80	0.38	0.54	0.13	0.80	0.38
9	Phosphate	0.46	0.13	0.72	0.32	0.48	0.16	0.73	0.30	0.47	0.14	0.73	0.31
10	Dissolved oxygen	5.77	1.33	7.45	3.40	6.26	1.42	8.15	3.75	6.01	1.37	7.80	3.57
11	Carbon-di-oxide	16.23	3.78	22.70	8.12	16.84	4.58	22.40	8.12	16.54	4.18	22.55	8.12

DISCUSSION

DISCUSSION

Various investigators in the field of hydrobiology have commented upon the inter-relationship between the various physical, chemical and biological parameters of different water bodies to understand their cummulative effect upon the growth and productvity of plankton and fishes on the basis of nature of water. As the physico-chemical properties of water are important determinents of aquatic eco-system, although they are greatly influenced and modified by climate and reparan vegetation (Hutchenson, 1967). The parameters were observed Keerat Sagar are being discussed to arrive at some conclusion.

Metereological Conditions :

They are quite important to effect the water body. which are :

Atmosperic temperature : :

The temperature of water is being influenced by the atmosperic temperature. When the atmosperic temperature rises then water temperature also increases and vice varsa. Its impact on productivity of biota in Keerat Sagar.

Rainfall :

Rainfall increases turbidity in the water due to silting and discharge of organic matters in rainy season, whereas turbidity decreases in winter season due to less rains and in summer it increases due to high wind velocity. This factor affects on photosynthetic activity and thus in the production of oxygen in the water.

Relative Humidity :

Relative humidity effects the atmospheric temperature. It decreases the atmospheric temperature in the rainy season because humidity is very high in monsoon period lower in winter and lest in summer, hence its direct impact on water temperature.

Photo period :

In the summer season photo period was found long shorter in monsoon and shortest in winter season: It effects positively in photosyntnesis which is resposible for the production of oxygen.

Colour :

The colour of the Keerat sagar water was muddy during the monsoon period (July to september) due to rains, which caused silting hence low transperancy and high turbidity resulting in low productivity of water in winter season (October to February) greenish and during summer season (March to June) dirty. The colour of the water in stanley reservoir was brown and greenish were observed (Ganapati and Sreenivasan, 1968). The greenish colour of the water was due to the presence of thick algal growth in a temple tank Devikund (Verma and Shukla, 1968). Obviously the colour of water is affected by silting, plankton and wind velocity. So its impact on the biota.

Depth :

Depth of a Sagar has an important role in bearing of fish fauna. As in shallow ponds sunlight penetrates upto the bottom, warmsup the water and facilitates increase in productivity, though ponds shallower than 1metre get overheated in tropics. So, summers inhibiting survival of fish and other organisms while depths greater than 5 metre are rare in fish ponds. Generally speaking a depth of about 2 metre is considered congenial from the point of view of biological productivity of a pond.

Water temperature :

Temperature is an important determining factor of physico-chemical and biological characteristics of the water. As the Sagar under study is shallow, fluctuations in the water temperature, together with other physical conditions i.e. strong winds agitation of water by the activities of men like washing bathing and swimming result in convection at currents.

The water temperature is influenced by various causes such as the ingress of feeder Madan Sagar water, climatic factors as clouds, rains, water level, humidity wind velocity and turbidity.

The heat from water is also lost by radiation, conduction and evaporation. Odum and Wilson (1962) reported that if the transparency of the water is reduced by reduction of light availability and thus its impact on primary production due to lack of photosynthetic activity.

In most of the Indian ponds temperature ranges from 7.8 to 38.5°C (Mishra et al 1975; Mishra et al., 1976, Bohra and Bhargava, 1972; Qadrui and Yausuf, 1980; Bhati and Negi, 1985, Singh K. V., 1983, Pant et al, 1985; Singhal et al, 1986; Thakur and Bais, 1987; Singh R.A., 1987 and Ghosh & George 1989).

During the present study of "Keerat Sagar", water temperature varied between 20°C and 32.4°C in the year 2001-2002 and between 14-6°C and 32.5°C in 2002-2003 at different sampling sites. The lowest temperature of water was recorded during winter (January) while the highest was noticed in summer (June) due to atmospheric temperature, and photoperiod. At station 'B' the maximum temperature recorded was comparatively lower mainly due to dense trees. But the variations inthe water temperature at diffrent stations were very narrow.

Chauhan M.C. 1999 found temperature in the maximum value 33.3°C Pahunj reservoir Jhansi. Mahajan et al, 1995; found temperature in the range of 13.0°C to 38.5°C in fresh water pond Barwani, Pathak (1997) has reported average maximum water temperature of various reservoirs (Ghandi Sagar 22.5°C, Nagarjun Sagar 27.5°C, Shahjahan garden pond 33.8°C, Rihand 24°C, Bhavani Sagar 25.8°C, Bachchra 26.7°C and Ayar 26.2°C) yogesh Shastri and D.C. Pandse 2001; found water temperature in the range of 18°C to 29°C in the hydrobiological study of Dahikhuta reservoir, L.C.

Saha 1987; found water temperature in the range of 18.4°C to 33.7°C in the physico-chemical complex of a perennial pond at Bhagalpur (India).

Keerat Sagar shows similarty with seekhe Jheell (32.6°C) which is a small water body almost of same geo-climatic conditions. Jhingaran (1992), also mentioned that stagnant waters of a tropical place lying in low rainfall area likely to have a high water temperature. Sagar is basically a multipurpose storage body drawing of water for irrigation purpose continuously decreases water volume making more susceptible to environmental changes. Whereas, running water shows wide fluctuation of temperature depending upon geology, meteorology and ecology etc.

The variation in the water temperature has an effect on all organisms including fishes. The distribution of fish reflects their responses to a variety of ecological factors; but temperature and dissolved oxygen content can be more closely related with their distribution (Brandt and wadley, 1981; Kramer, 1987; unger and Branat, 1989). According to Jhingran (1985), the Indian major carps can tolerate a wide range of temperature i.e., 18.3 to 37.8°C. However, Srivastava (1985) mentioned that the range is between 20 to 37°C for Indian major carps. In the present study the fluctuation of temperature was always found to be within the limits as suggested by Jhingran (1985) and Srivastava (1983) though the maximum production was recorded during summer season, but significant statistical co-relation between fish production and water temperature could not be estabblished.

Turbidity:

Turbidity in water is caused by the substances not present in the form of true solution. True solutions have a particle size of less than 10^{-9}m. Any substance having more than this will produce a turbidity. Turbidity in natural water is caused by clay, silt, organic matter, phytoplankton, zooplankton and other microscopic organisms. Stone quarrying works, sand washing, china clayworks are inorganic wastes,

increase turbidity. Domestic wastes, sewage effluents and many coal, washing effluents etc. cause turbidity by organic wastes. Turbid water possesses a number of problems in water treatment plants.

The turbidity of natural waters may be either due to suspended inorganic substances such as silt and clay or due to planktonic organisms. It is an important limiting factor in the productivity of a pond. Turbidity varies greatly with the nature of the basin, degree of exposure, nature of inflowing sediments etc. Ponds with clay bottoms are likely to have high turbidity ,rock basins and ponds in which sand gravel predominate are likely to have low turbidity. Singhal et al; (1986) have reported the turbidity ranging between 15 to 67.5mg./l. in man made managed ponds of Haryana.

According to wallen (1951), the natural turbidities are seldom if ever, directly lethal to fish. But the turbidity may effect the productivity of an aquatic ecosystem. Wilson (1959), believes that it hampers the spaning and growth of Fish. ssssssFish and some invertebrates suffer from such pollution because their gill surface are clogged with suspended matter. In Garhwal region of (U.P., India) the high turbidity in water is caused by soil erosion and turbulence of water during flash floods. It has played a major role in disturbing the river beds, microhabitats of macro invertebrates and other organisms and thus causing depletion of the fish fauna in recent years (Singh and Badola, 1978).

Indian standards permit turbidity up to 10 N.T.U. In the absence of any alternative source. Turbidity level exceeding 10 N.T.U. in the drinking water effect the aesthetic quality of water significantly and at this level water may not necessarily be safe from hygeinic point of view because under such conditions become very difficult to maintain the minimum desirable limit of residual chlorine in the water. Besides this, turbid constituents tend to protect and shield micro-organisms against

the bactericidal action of chlorine. Therefore, the prevalence of harmful micro organisms in such type of water can not be ruled out. Turbidity constituent produce sssssss sive action on the pumps and pipe lines. Turbidity has been traditionally measured in JTU (Jackson turbidity Unit). Currently Nephlometric turbidity units (NTU) are used employing Nephlometer in turbidity estimation. The health limit for turbidity is 5 N.T.U. as recommended by WHO. Coagulation, flocculation, sedimentation and filtration of water is mecessary for turbidity removal.

Kataria et al. (1996) studied the limno chemical characteristics of Tawareservoir and noticed that the turbidity varied between 8.0 and 40.0 N.T.U. water quality of Amarnath pond and Tikanagar pond of Rounkele examined by Naik et al, (1996) and reported turbidity between 18.0 to 62.0 and 13.0 to 47.0 NTU.

In the present study the turbidity of Keerat Sagar ranged from 14.02 to 62.00 N.T.U. during the first year and 15.6 to 69.20 in the second year of study. The highest value of turbidity 69.20 NTU was recorded at station N-C in August 2002-2003. The higher trend was observed in summer and monsoon period. (July to August) due to low level of water and high wind velocity and silting respectively. The lowest value of turbidity 14.02 NTU was recorded at station-0 in December and January due to lack of silt and low wind velocity.

Turbidity due to profusion of plankton is an indication of pond's high fertility but that caused by silt or mud beyond a limit, is harmful to fish and fish food organisms. Turbidity restricts the penetration of sunlight and hence reduces phto sy nthetic activity which, inturn, is related to the productivity of a water mass. The suspended particles causing turbidity may also adsorb considerable amount of nutrient elements, like phosphates, potassium and nitrogen in their ionic forms making them unavilable for plankton production.

pH (Hydrogen-ion concentration):

Hydrogen-ion concentration is an important chemical factor of the water of which the nature of water is determined. Generally the water is considered natural but the natural waters are never so. The pH in natural water depends upon the amount of corbonates, bicarbonates and co_2 tension. The later is effected by photosynthesis of aquatic vegetation and respiration of animals.

pH indicates the intensity of acidity or alkalinity and measures the concentration of hydrogen ions in water. Acidity or alkalinity depends upon exces of H^+ or OH^- ions and measured in normality or gram equivalents of acid or alkali. Generally most of the surface waters are alkaline in nature with an average pH range of 7.0 to 8.5.

The pH of natural water is an important environmental factors, the variations of which among other causes is associated with the composition of species and life processes of animal and plant communities. It also serves as a valuable index to the nature of pollution and gives an idea of the intensity of pollution Verma et al (1984).

pH in most natural ponds, lakes and tanks is alkaline throughtout (Verma, 1964, 1964; Ganapati and Sreenivasan, 1968; Verma and Shukla, 1968, Pant et al, 1979; Qadri and Yousuf, 1980. Nayak et al, 1985, Saha and Pandit, 1986; Singhal et al, 1986; Ramani bai and Ravichandran, 1987 and Ghosh and George, 1989).

In the present study, Keerat Sagar showed alkaline nature throughout the study period. pH value varied between 7.5 and 8.5 in the year 2001-2002 and between 7.5 and 8.2 in 2002-2003 at different sampling site. The lower value of pH was recorded in rainy season, which might be due to increased water volume, that brings change in the level of carbonates. pH showed positive co-relation with total alkalinity.

The pH in monsoon period (July to September) was noticed comparatively (Ray et al, 1966), which ws apparently due to the dilution of water (Parmeswaran et al, 1971), more turbidity and addition of carbon-di-oxide in the form of carbonic acid from the rain water (Chakrabarty et al, 1959). the higher pH values in the summer month of June, were probably due to much concentration of HCo_3 and high decomposition of organic matter. The pH also affects the diurnal and seasonal changes as worked out by worthington (1930). Juday et al (1935) and Hutchinson (1957).

As regords the suitability of pH many workers have given different views in respect of the growth of plankton and other macro fauna in different water bodies. Ohle (1938) gave the pH limit of 4.8 and 10.8 below or above which has harmful effects. Ganapati (1943) reported pH ranging from 7.6 to 7.8 in Madras tanks. Banerjee (1967) after investigating nearly eighty ponds concluded that pH 6.5 to 7.5 is most suitable for a fish pond, while a pH range of 7.5 to 8.5 is for average production.

The present work is an conformity with other studies conducted by Singh K.V. (1983), Singh R.A.(1987) Bharati et al, (1990), Malviya (1990), Singh et al, (1990), Verma et al, (1992), Agrawal (1993), Sivasubramani et al, (1995), Mitra (1997), Doctor et al, (1998), Nanda and Tiwari (1999), B.P. Mishra and B.S. Tripathi (2003), B.N. Sunkad and H.S. Patil (2003).

Swingle (1967) reported that water having a pH ranged of 6.5 to 9.0 are most suitable for fish culture while Hora and pillary (1962) found the pH range between 7 to 8 more conducive for fish culture. The suitability of alkaline nature of water for fish culture was also reported by alikunhi et al. (1955), Dubey and Verma (1966) and Das and Pathani (1978). THE range of pH of Keerat Sagar also resembles with the studies of the above.

Carbonates :

In the present study of Keerat Sagar carbonates throughout the study period. Values varied between 5.50 to 17.50 ppm in the year 2001-2002 and between 6.75 to 16.65ppm in 2002-2003 at diffrent sampling sites.

During the process of photosynthesis, Co_2 is removed, thus in creasing the carbonates. Wiebe (1930) suggested the pH is controlled by the photosynthesis and it would follow that pH and corbonates would vary directly. An apparent co-relation was found between pH and Co_3 in the water of Rogers lake by Lauff (1953) Cited by George (1961). A similar relationship was also found in Keerat Sagar during the period of investigation. This is in conformity with the findings of lauff (1953) under tropical conditions.

Bicarbonates :

In the present study of Keerat Sagar Bicarbonates throughout the study period, values varied between 136.30 to 196.30ppm. in the year 2001-2002 and between 36.20 to 198.50ppm in 2002.2003 at diffrent sampling sites.The mean values of bicarbonates in the study period of 2001.2002 varied from and in 2002.2003 varied from 138.4 to 198.2ppm at diffrent sampling sites.

Bicarbonates increased with the addition of animal excreta.The bicarbonates showed direct relationship with free except in july.There was a simultaneous increase or decrease in both the factors.

Total Alkalinity :

Reid (1967) described that natural water may have four different components responsible for alkalinity.These are bicarbonate-ions of calcium (Ca), magnesium (Mg), Sodium (Na)and Potassium (K) etc.

During the present study of sagar total alkalinity varied between 177.80 to 208.80ppm in the year 2001-2002 and between 147.20 to 210.48 ppm. in 2002-2003 at diffrent sampling sites.

Alikuhni (1957) stated that productive waters usually possess more than 100mg/l. alkalinity. Pathak (1997), reported lowest alkalinity for Rihand 43.8mg/l and highest for Bacchara 127.64mg/l. Average alkalinity for Indian reservoir comes around 68.8mg/l (khan, 1977). Natural water bodies show wide fluctuation of alkalinity depending upon geology, meteorology and ecology etc.. Jhingaran (1992), mentioned that, stagnant water of tropical places lying in low rainfall area, likely to have a high total alkalinity. Seasonal variation exhibit relationship with rainfall, water quantity plankton population and sunlight. Alkalinity directly affects the well being of fishes, because low values are biologically less productive than those with high values.

High values of alkalinity indicate the hardness of pond water which helps in the production of biomass. According to Hutchinson (1957) high alkalinities are indication of super saturation of calcium carbonate L.C. Saha (1987) explained total alkalinity fluctuated within a wide range in 82 to 146 ppm. increased alkalinity during summers might be due to increased rate of decomposition and depletion in water level. Yogesh Shastri and D.C. Pendse (2001) mentioned alkalinity plays an important role in controlling cnzyme activity.

The values of alkalinity studied were maximum during summer season, when the fish production was also high Bicarbonate alkalinity is essential for productivity because it has a ready stock of carbon-di-oxide for the photo synthesis. Total alkalinity is positively co--related ($r = 0.57$, $p < 0.001$) with fish production. The low values of alkalinities were recorded during winter and rainy season, which also caincided with low production of fish in the same season. Rowson (1958) observed that an increase in standing crop of fish with the increase in alkalinity, and low

standing crop of fish with the decrease in the value of alkalinity in lakes and reservoirs. In the present study such relationship was found.

Chloride :

Chlorides are one of the most constant component of water. Their concentration hardly changes, when physico-chemical and bio-chemical processes take place in water, chloride, in reasonable concentrations is not harmful to human but as concentration increases above 250mg/l. they give a salty taste to water and affects the palatability of water, BIB has set desirable limit of chloride to be 250mg/l for drinking water and 600mg/l for water to be used for irrigation purposes.

The level of chloride is an important consideration in the selection of supplies for human and agricultural use considerable increase in chlorides in water may be connected with the pollution from house hold sewage, human and animal excreta have high quantity of chlorides along with nitrogenous compounds. Chloride is said to be accompanied with faeces. Hence increase in its concentration may serve as one of the signals of faecal pollution.

In the present study Keerat Sagar chloride values varied between 10 to 46.10ppm in the year 2001-2002 and between 10.00 to 43.50ppm in the year 2002-2003 at different sampling sites. The lower value of chloride was recorded in rainy season (August- September) and higher value was recorded in summer (May-June). The increasing trend was found at station A-B and C due to sewage and human interference like mass bathing activities and other extraneous sources. Gonjalves and Joshi (1946) reported that the chlorides depend on the water level, as investigated in a tank at Bandra near Bombay. They noticed an inverse relationship between chloride content and water level.

In the present investigation also, such an inverse relationship was absberved. As in June the water level was low the chloride contents were high due to less quantity of water and much concentration of organic matter, while in the July and August with the increase in water level the chloride contents were found decreasing considerably due to dilution of water. From september onwards when the water level again decreased, chlorides were found to increase, establishing an inverse relation between the chlorides and water level.

Some workers have reported very low chloride contents while others found very high values of chlorides in different water bodies. The Significant reports of very high chlorides values have been given by Ganapati (1940). Who observed minimum chloride concentration of 40.2ppm and maximum of 63.0ppm in a tample tank in a garden pond in south India. Singh K.V. (1983) reported maximum chloride in summer season and minimum in rainy season. Further an inverse relationship was also observed between the chloride and zooplankton. Yogesh Shastri and D.C. Pendse 2001; found maximum anoant of chloride was 63.9ppm in month of June and minimum 31.24ppm in the months of July and August in the Hydrobiological study of Dahikhuta reservoir. Dhankpakiam et al, 1999; also recorded lower value of chloride in rainy season. The maximum amount of chloride in summer confirmed by the influx of high contaminated domestic sewage.

Thus chloride concentration is an importent factor in estimation of the quality of water.

Ammonical Nitrogen :

The most important source of ammonia is the ammonification of organic matter. High concentration occur in water polluted by sewage or some kinds of industrial wastes containing either organic nitrogen or directly ammonia or ammonium salts. Sewage has large quantities of nitrogenouns matter, thus its disposal

tends to increase the ammonia content of the waters. Occurrence of ammonia in the water enable to understand the chemical evidence of organic pollution. If only ammonia is present, Pollution by sewage must be very recent. The occurrence of nitrite with ammonia indicates that some time has been lapsed since the pollution has occured. If all the nitrogen is present in nitrate form, a long time has been passed after pollution, because water has purified itself and all nitrogenous matter has been oxidised.

Certain aerobic bacteria convert ammonia into nitrites and then into nitrates Nitrogen compounds serve as nutrients for aquatic micro-organisms and may be partially responsible for the eutrophication of lakes and streams. The presence of ammonia in ground water is generally a result of natural degradation processes. Ammonia in higher concentration is harmful to fish and other biota. The upper permissible limit for ammonical nitrogen for drinking and irrigation water is 1.5 to 5.0 mg/l.

In the present study Keerat Sagar ammonical nitrogen throughout the study period, varied between 0.35 to 0.80ppm. in the year 2001-2002 and between 0.30 to 0.82ppm. in 2002-2003 at diffrent sampling sites. The contents of ammonia were high in summer season, due to high decomposition of organic matter, excreta and also because of high alkalinity and temperature of the pond water during summers. The summer maximum of ammonia concentration was also observed in may-June (Hutchinson, 1957). An about decrease in ammonia concentration was found in August due to the dilution of decaying organic matter by rain water and lateron on gradual increase during september, october and november.

Ganapati (1940, 41) reported ammonia concentration between 0.003 to 0.216 ppm in a temple tank and in 1943, 0.018 to 0.288 ppm in a garden pond of south India. During hydrobiological survey of fresh water ponds of U.P. wide ranges of

ammonia concentration from 0.059 to 0.378ppm was reported by Alikunhi et al. (1964). Niemi (1985) observed the range of ammonical nitrogen between BDL and 0.85 mg/l in Firnish lake Parvateesan & Gupta (1994) reported the high value of ammonical nitrogen varied from 1.1 to 3.9mg/l in the lake water and concluded that its higher concentration was due to the accumulation of dissolved organic wastes.

In the present study ammonical nitrogen concentration was found within the permissible limit hence this water is suitable for fish production and other biota besides it is useful for irrigation and drinking purposes.

Phosphate :

Nutrients play an important role in the metabolic activities of the plant and animals. Phosphorus is one of the major nutrients responsible for biological productivity Phosphorus data have great importance in environmental studies because of their significance as a vital factor in life process.

In unpolluted bodies of water, phosphates are formed mainly during certain biological process of transformation of organic substances to inorganic phosphates during the vegetation period, the phosphates of soluble form are readily taken up by aquatic plant organisms mainly phytoplankton. Considerable irregular increase in the concertration of phosphate indicates the presence of pollutants. Major sources of phosphates are domestic sewage detergents, agricultural effluents with furtilizers which may enter in the water body in significant amount alongwith the run-off water from the catchment area.

Phosphates are amongst the important nutrients found in ponds, tanks and lakes are used during pohtosynthesis by the green algae and bacteria. Recently Hutchinson (1957) and Ruttner (1963) reported that phosphates are the limiting factor, as it is one of the major nutrients. Hence the deficiency of phosphorus as

phosphates is likely to limit the productivity of water, than the deficiency of any other material.

In the present study Keerat Sagar phosphate throughout the study period. Varied between 0.25 to 0.72ppm. in the year 2001-2002 and between 0.26 to 0.73ppm. in 2002-2003 at diffrent sampling sites. Phosphate contents were highest during rainy season, fairly high in autumn and lowest in winter. This is in conformity with work of Subba Rao and Govind (1964). At station 'B' the phosphate contents were very high due to heavy contamination of organic matter, as the excreta and plant leaves fall in pond water.

In the present investigation also the concentration of phosphate was recorded high in the rainy season due to agricultural run-off. The observations is obtained are in conformity with the observations of Singh K.V. (1983), Singh R.A. (1987), Rao et al, (1995), Panda & Singh (1997), Mohan & Hosett (1998). Pande & Sharma (1999), Yogesh Shastri and D.C. Pandse (2001) B.P. Mishra and B.S. Tripathi (2003)., B.N. Sunkad and H.S. Patil (2003).

During the investigation period an inverse relationship was noticed between the green algae and phosphates in the summer month of June when chlorophyceae in months (October and November) with the decrease of green algae, the phosphates were found to increase. This was probably due to the accumulation of phosphate as phosphorus ions in the cells of phytoplankters during metabolic activity. The disappearance of added phosphorus within few days resulting in the high production of phytoplankton, was reported by Phillips (1964) However, in the monsoon period (July to September) a direct co-relation between the green algae and phosphate was found which may be due to surface run-off of the rain water and low rate of photosynthesis.

In the present study it was observed that zooplankton showed direct relationship with phosphates in summer and autumn as the ex creta phosphate while in rainy season an inverse relationship was found which was perhaps due to the the heavy influx of phosphates through rain water.

Dissolved Oxygen (D.O.):

Dissolved oxygen is one of the most important parameters in water quality assessment and further effects chemical and biological processes prevailing in the waters. It is essential to the production and support of biological life in water and necessary to the decomposition and decay of organic wastes and decreased organisms. Oxygen is consumed by the respiration of plants and animals, by bacteria decomposition of organic matter and by the chemical oxidation of waste substances. It plays an important role in the organic cycle of river water also. The main source of oxygen in water is from the atmosphere. Oxygen is dissolved into the upper layers of the water body through the air inwhich it is dispersed throughout the water body by wind and wave action vertical mixing and other forms of agitation.

Dissolved oxygen plays an important role in evaluating the condition of the habitation of the flora and fauna in a water body. Oxygen saturated waters have a pleasant taste while the water lacking oxygen have an insipid taste. The water quality criteria according toC BPCWP (1985), Suggests a level of dissolved oxygen 5mg/l or more is suitable for drinking purpose. BIS suggests for inland surface waters a level of D.O. as >6.0>5.0>4.0 and >3.0 mg/l under class "A" to "B" respectively VESPA reported the D.O. variation in the range of 7.1 to 9.3mg/l.

In the present study Keerat Sagar showed dissolved oxygen value varied between 3.38 to 7.60ppm in the year 2001-2002 and between 3.75 to 8.40ppmin 2002-2003 at diffrent sampling sites. Dissolved oxygen was higher during winter and lower during Summers.

The pond water receives oxygen by absorption from the atmosphere at the surface and by photosynthetic activity of inhabiting chlorophyll bearing organisms. High value of dissolve oxygen during winter season and low oxygen during summer and rainy season have been observed by many workers Verma, 1967, Verma and Shukla, 1968; Bohra and Bhargava, 1977; Nayak et al. 1982; Saha and Chaudhary 1985; Singhal et al. 1986 and low dissolved oxygen during summer has been determined by Munshi, 1974 and Pant et al, 1985. The present work is in conformity with other studies.

Singh K.V. (1983) and Singh Ramashrey (1987), L.C. Saha (1987); found dissolved oxygen was higher during winter and lower during summers. It is in conformity with the low of solubility of gases, according to which the periods of high temperature should be the periods of low oxygen content. Rate of decomposition might be playing an important role in controlling oxygen level during higher temperature there is greater decomposition in which dissolved oxygen is invariably utilised leading to fall in its value in the physico chemical complex of a perennial pond at Bhagalpur (India). Yogesh Shastri and D.C. Pendse 2001; found Dissolved oxygen minimum of 4.83 ppm was recorded in July while maximum of 12.08ppm was recorded in the month of November in the hydrobiological study of DahiKhuta reservoir. B.N. Sunkad and H.S. Patil 2003; dissolved oxygen ranged narrowly from 6.68ppm to 8.9 ppm. The primary pulse of DO recorded in these month may be associated with higher planktonic biomass which forms one of the major sources of DO as by product of photosynthetic activity in the water quality assessment of Rakasakoppa reservoir of Bilgaum, Karnataka.

Dissolved oxygen content is also important for controlling the fish movement. Generally fish prefer warmer areas with higher DO according to Sreenivasan (1970), under low DO condition the fishes are Subjected to stress, and their movements are restricted. Hence, DO plays an important role in fish and other biota productivity

Carbon-di-oxide (CO_2):

Carbon-di-oxide in natural water is derived from the atmosphere respiration of animals and plants, bacterial decomposition of organic matter in flowing ground water and remain in combination with other substances chiefly calcium and magnesium in water. During day time, carbon-di-oxide is lesser due to its utilisation in photosynthesis; while during night time it is greater because it is given off as a result of respiration by aquatic organisms. Carbon-di-oxide is highly soluble in water.

In the present study of Keerat Sagar carbon-di-oxide value varied between 8.4 to 22.7ppm in the year 2001-2002 and between 7.9 to 22.9ppm in 2002-2003 at diffrent sampling sites. Highest value was in summer season and low value in winter. This was due to the decomposition of organic matter under high temperature which consumes oxygen and liberates carbon-di-oxide. CO_2 showed an inverse relationship with dissolved oxygen. The highest concentration of carbon-di-oxide was found at station 'B' due to high decomposition of organic matter added in the form of animal excreta. Free carbon-di-oxide may be present throughout the year (Verma, 1964; Bohra; 1977-78; Agrawal, 1978; Qadri and Yousuf, 1980; nayak et al, 1982; Singh K.V., 1983; Saha and Pandit, 1986 and Singh R.A., 1987; Yousuf & Shah, 1988). The absence of free carbon-di-oxide may be explained on the basis that either it is completely utilised by the phytoplankton or it is converted into carbon-di-oxide and finally into stable carbonates and bicarbonates, while its presence in the pond may be attributed to its non-utilisation in photosynthesis or to the diffusion of carbon-di-oxide from air. Whatever the case may be, the carbon-di-oxide is never a limiting factor in planktonic growth (Sarkar and Rai, 1964).

The carbon-di-oxide showed an inverse relationship with carbonates in most of the months of the investigation period as during photosynthesis carbon-di-oxide is removed from the solution, thus, increasing the carbonates while a direct rela-

tionship was found with the bicarbonates, because the carbon-di-oxide forms stable carbonates.

The importance of free carbon-di-oxide for an aquatic environment derives from three factors (1) chemically it acts as buffering agent against rapid shift in acidity alkalinity state (2) It regulates biological process in aquatic communities (3) It is the most versatile element which can form numerous compounds. Both lower and exceptionally higher values of free carbon-di-oxide are harmful to fishes (Lagler, 1982) It is in confirmity with the present study.

Aquatic Weeds ;

Aquatic weeds are the undesirable plants that grow in water and are more harmful than beneficial for fish culture. Excessive growth of aquatic vegetation prevents effective utilisation of water and reduces productivity. They check free movement of the fish and cause oxygen depletion and accumulation of carbon-di-oxide. Gases like hydrogen sulphide and methane are formed which are hormful to the fish. Algal blooms choke the gills and spoil the water on rotting.

They are found in and nearby of the Keerat Sagar Floating species were-

Lemna paucicostata, Trapa natans, Eichhornia crassipes, Nelumbo spp, Azolla spp., Pistia spp, spirudilla polyrhiza etc. Their growth started from october and make scum in shore region and they began to deplete from April onwards. Pistia spp. appeared in July as it came along with the monsoon and finally is got settled only in shallow areas. During the present study there was a remarkable increase in the pistia spp. infestation. Emergent weeds represent only Potamogeton spp. They were in small number and disappear in monsoon period. Marginal plants such as cyperus corymbosus, Ipomoea aquatica, Polygonum glabrum were also observed in post monsoon period. They die as water recedes from shallow region of sagar. Submerged weeds such as Nazas minor, ceratophyllum demersuom, vallisneria spiralis

are most abundant among all plant communities and often occupy entire water body except deeper regions making them quite important from fisheries point of view. Ceratophylum spp. and Vallisneria spp are the most abundant in the entire sagar. Their density become less in monsoon period. While vallisneria spp. occurs only in shallow region. Hence, the sagar is eutrophic which is fulfilled from rich organic material, planktons and aquatic weeds.

It is worth to be mentioned here that under the current management practices lake receives a sizeable number of grass carp seed (Ctenpherangodon idella), as they are ideal herbivorous fishes and voraciously devours Potamogeton spp, Hydrilla spp, vallisnaria etc. Alikiuhni and Sukumaran (1964) proved their efficiency for the control of aquatic weeds. It was also marked in the present study.

Phyplankton :

Studies on the ecology of phytoplankton of any water body is very helpful to know its general economy and to understand the basic nature of the waters. All waters are known to be characterised by quantitative and qualitative fluctualion in the phyto-plankton popluation. The pattern of seasonal fluctuations in water temperature largely agrees with the changes in solar radiation. Maximum densities of phytoplankton were observed during pre winter and post winter period when temperature was suitable for their growth and reproduction. (Table [illegible]). Seasonal fluctuation in temperature and turbidity values were noted in the sagar in relation with phytoplankton density. The occurence of seasonal qualitative and quantitative fluctuations in plankton population apparently disappeared at specified periods and reappeared during others. Singhal et. al., (1986) observed direct relationship between pH and phytoplankton. Nitrogen and Phosphorus, the two important nutrients, show positive relationship. Phytoplankton population increases with the increase in concentration of these nutrients. Dilution of water due to monsoon inflow causes depletion in phytoplankton density. The two recorded pulse of phytoplankton during pre

and post winter seasons concides with the greater availability of nutrients. Seasonal variation of each group and indivisual species were also studies.

In the present study positive relationship of phytoplankton was noticed with ammonical nitrogen, phosphate whereas inverse relation with turbidity and low pH and photo period and tumperature will effect diurnal variation.

Chlorophyceae :

This was the first largest group of the phytoplankton found in investigation. The various genera of chlorophyceae exhibt seasonal variations dominant genera were Tetraspora protococcus, scnedesmus, Actinastrum. Scendesmus is known to be the most lerant to pallution and may thrive very well in polluted waters (Palmer, 1969). It prefers high temperatures and exhibits only one maxima in summer. Tetraspora is another dominant group which never disappears from sagar. Spiro-gyra, coelostrum, Zygnema, Ulothrix were rarely found during the study.

Temperature has been considered as an important factor for regulating the growth and distribution of chlorophyceae. Rao (1955)_, Zafer (1968), Mehra (1976) observed the maximum growth of chlorophyceae in warmer months of the year. Munawar (1976) reported that the first maxima of chlorophyceae occurred during summer and second during monsoon and persistent during early winter when temperature fluctuated between 20 to 30°C. Kant and Kachroo (1977) Kant and Anad (1978) described a gradual rise in temperature from February onwards, as optimum condition for growth and reproduction of chlorophyceae. Sarwar and Zutshi (1988) had also reported the maximum number of chlorophyceae during summer season. Paarsall (1932) and Govind (1963) have described the importance of nutrients in the development of chlorophyceans. Pahwa and Mehrotra (1966) recorded that members of chlorophyceae were very sensitive to fluctuation of phosphate concentration. Vilicie (1989) reported a positive co-relation between phytoplankton

population and phosphate concentration in water.

In the Keerat sagar group chlorophyceae varied from 588 org/L to 273 org/l during the investigation. They were maximum in summer and minimum in monsoon period. Its impact an the colour of the water.Imparts green.In the present study positive relationship was found with temperature and phosphate.

Bcillariophyceae:

In the present study group bacillariophyceae range from 266 org/L to 77 org/L in the months of September and April respectively. They were maximum in summer season and minimum during monsoon period.

Vyas (1968) recorded two peaks of diatoms in October and May in the pichola lake of Udaipur. Chakkraborty et. al.(1959) recorded two peaks of Bacillariophyceae in early summer and early winter. George (1960) found diatoms peak in winter season while Kant and Anad (1978) observed the maximum number of diatoms during monsoon season. Sharma and Pant (1979) found the Summer peak of diatoms in Bhimtal lake. Chang and Rossmann (1988) recorded diatoms peak in April and Mahoney (1989) reported the peak of diatoms in April. During the study period Naviculla and synedra species are dominant of diatoms. Diatoma and Frustulia are narely found in diatoms sagar. They affect on the colour of the water, which becomes brownish.It was also observed in the present study.

Myxophyceae:

This was the second largest group of the phytoplankton. In the present study group myxophycae range from 385 org/L 188 org/L. They were maximum in summer and minimum in monsoon period and post winter season. Blue green algae thrive virtually in all aquatic ecosystem bacause they have an extraordinary functional and structural heterogencity Carr and Whitton, (1973); Fogget. .(1973). Blue

green algae benefits not only for photosynthetic ability but for their chemotrophic and heterotrophic capibilities too. Microcystis was the most dominant member of blue green algae. Sreenivasan (1970) observed microcystis bloom thoughout the year. Except in the month of April in a reservoir at Madras. Tetrapedia, Anabaena, Oscillatoria were rarely found in sagar. Tiffany and Britton (1951) Khan et. al., (1978) and Sharma and Pant (1979) associated the dominancy of blue green algae with hot summer months. Rao (1955) recorded the importance of sunshine while pearsall (1923) and Ab Hussein and Inason (1988) gave more importance to high temperature for the development of cynophyceae. A direct relation of blue green algae with temperature was also reported by Vyas (1968).It is in confermity with the present investigation.

Blue green algae was able to use bicarbonates more effeciently than other species of algae there by enabling them to photosynthesize at lower Co_2 concentration and resulting in more carbonates during their abundance King, (1970), Paerl and Vstach, (1982); Shaprio, (1984). Due to this fact a positive co-relation was found between population of blue green algae and carbonates alkalinity. It was also observed in the present study.

Zooplankton :

The number of zooplankton remain lesser than to the phytoplankton. This trend was also evident in the present water body, except during March and April when zooplankton takes over the phytoplankton population. It may be due to excessive grazing of phytoplankton by zooplankton in otherwise suitable conditions. Fluctuation in zooplankton population is an established fact and several workers had reported changes in the density George, (1962); Patil, (1976); and Khan, (1990). Parker (1961) and Hutchinson (1967) had pin pointed several factors responsible for fluctuation of zooplankton population. Prasad (1956) reported higher the density of phytoplankton, higher the number of zooplankton. He further explained that

zooplankton number increases with phytoplankton because of their basic dependence over later. George et. al. (1967) emphasized that temperature is the single most critcial environmental factor controlling the reproduction of zooplankton. Zooplanktonic community of Keerat sagar consisted of Rotifers , copepods, Protozoans and cladocerans in the order of dominance conspicuous seasonal variation of zooplankton were observed during the study period. The population of zooplankton ranged from 421 org/l to 110 org/L. The maximum number of zooplankton was recorded in the month of June and seasonal peak was found during summer season. The few species of Rotifera dominated over crustaceans and protozoans, during the summer month of June. Atkins and Harris (1924) also reported such seasonal changes in the water and heleo plankton of fresh water ponds.

In the present positive relationship of zooplankton was recorded with temperture and phytoplankton .The zooplankton are the immediate consumers of the phytoplankton. The plankton play an significant role in the bearing of fish life.

Fish fauna :

In the present study economically important 12 species belonging 10 genera representing 8 families were study in Keerat sagar Gunther (1980) found 26 families in India.. Zoological survey of India (1991) has published that about 4000 species of fishes are found in all India waters, . Heteropneustes fossilis, Clarius batrachus, Labeo rohita, are more abundant in sagar. This may be attributed to muddy bottom of lake and comparatively appropriate explaitation practices. From seasonal fluctuation point of view dissolved oxygen and dessication of sagar are important factors usually Indian major carps are the Versatile. Chanda spp. were present in the upper column of deeper region of sagar while minor carps remain in shore areas. Former two species Catla catla, Labeo bata were also abundant in winter when dissolved oxygen level was higher while the later common in summer when vegetation grow more. Cirrhinus mrigala is another fish which is distinctly more abundant in sagar. The fishes in sagar are of 8 familes which are :

Cyprinidae : 4 species of cyprinidae family were found Catla catla is found on surface and it is plankton feeder, Labeo rohita predominantly calumn feeder and planktophage, Labeo calbasu omnivorous detritus feeder, cirrhinus mrigala bottom feeder herbivore fishes.

Bagridae : One species of this family were found Mystus seenghalla is a bottom feeder herbivore fishes.

Siluridae : One species of this family were found Wallago attu is a highly carnivore and predaceous fishes.

Clariidae : One species of this family were found clarius batrachus bottom feeder carnivore fishes.

Heteropneustidae : one species of this family were found viz Heteropneustes fossils bottom feeder omnivore fishes.

Centropomidae : Two species of this family were found in the sagar chanda ranga, chanda nama.

Ophiocephaldae : One species of this family were found channa marulius highly carnivoroe and praedeceous fishes.

Notopteridae : One species of this family was found Notopterus chitala.

Animals and plants are important contributor of the environment and successful establishment of a species in an ecosystem depends on its tolerance of physico-chemical variables, its relation with other organisms and its behaviour which is more important during reproduction. Macan (1974) and Reid (1961) summarised that successful development and maintenance of a population depends on harmoni-

ous ecological balance between environmental conditions and tolerance of the organism to variation in one or more of these conditions. This idea suggestes that either one or the other factor can limit the population. A factor that exerts in fluence upon a population through its compatibility is said to be a limiting factor. It may be a physical, chemical or biological feature. Intraspecific competition for food space and breeding is equally important. Every lake or pond has its own distinct fauna. As discussed earlier each species is generally confined with in a certain range of physico-chemical and biological parameters. Thus some species flourish in the congenial and some remain at low level. Fish producti on is related to this fact upto certain extent. Preserevance of biodiversity and increase in productivity work at cross purpose. Macan, (1974).

In the Keerat sagar the fish fauna and it productivity is poor, because the inlet and outlet of the sagar are not managed properly upto the mark Obviously water circulation and water level are not managed. This sagar is fedup by dense vegetation viz- Trapa, Eichornia, etc.

So the measures will be taken for the above drawbacks, to maintain this sagar scientifically managed for the suitabilityfish fauna & its productivity.

Chemical conditions of soil :

Soil plays on important role in determining the fertility of ponds. The fertility of soil refers to its nutrient releasing properties for the benefit of land and aquatic crops bearing on it. From the stand point of crop production soil fertility relates to four stage : (i) The nutrient requirements of crops and their release from soil (ii) the status of as a storehouse of nutrients (iii) the way nutrients are leached from the soil and (iv) the methods permitting to maintain or restore soil fertility. In the case of aquatic crops, the nutrients are directly required by micro and macro

vegetation and certain bacteria that may grow in fishery waters. In this respect major important chemical factors are pH available nitrogen, phosphorus and potassium. Banerjea (1967) has surveyed the soil condition and water quality of a large number of ponds from different soil zones of Eastern and central India in relation to the production of fish. The important chemical characteristics of Keerat sagar soil are :

pH :

The pH of the sagar soil depends on various factors. Sagar mud is well aerated. The decomposition of organic matter is slow and the products formed of decomposition are hydrogen sulphate, methane and short chain fatty acids which make the soil alkaline, unless the soil is naturally buffered, it reduces the rate of bacterial action influencing productivity.

The pH of soil also influences transformation of soluble phosphate and controls the adsorption and release of ions of essential nutrients at soil water interface. The ranges of pH organic carbon, C/N ratio etc in relation to pond productivity as observed by Banerjee (1967) in a number of fish ponds from selected region of India.

In the present study of sagar soil pH range from 8.0 to 8.6 that is alkaline in nature which is suitable for fish production.

Phosphorus :

Phosphorus is most important for the aquatic productivity. Available soil phosphorus shows a definite positive co-relation with fish production. Banerjea (1967) has grouped pond soils studied by him under four ranges of available phosphorus :< 30ppm, 30 to 60ppm, 60 to 120 ppm and 120 ppm. soil phosphorus (P_2O_5) level < 30 ppm is considered indicative of poor, the range 30 to 60 ppm of

average, and the level > 60 ppm of high fish production. In Tamilnadu, Sreenivasan (1967) observed that soils with available phosphorus less than 0.5 ppm are in low productive groups (500 Kg of fish/ha.); those with available phosphorus between 0.5 to 1.0 ppm) in the moderate productive group (500 to 1,000 Kg of fish/ha.) and soils with available phosphorus > 1.00 ppm in the highly productive group (> 1,000 Kg of fish/ha.). Phosphorus occurs in soil in both inorganic and organic forms. The organic processes of phosphorus fixation depends largely on pH apart from other factors and has been studied by Banerjea and Ghosh (1970) in respect of highly acidic soil of pH < 4-5 from Tripura : moderately acidic soils of pH 4.5 to 5.5 from Manipur; slightly acidic soils of pH 5.5 to 6.5 from Assam; near neutral soil of pH 6.5 to 7.5 from Orissa; moderately alkaline soil of pH 7.5 to 8.5 from west Bangal and highly alkaline soil pH > 8.5 from Andhra Pradesh.

In the present study phosphorus range 10.15 to 42.0ppm. The high range of phosphorus was due to run off and decomposition of aquatic weeds . Hence during be lower range of Phosphorus concentration fish productivity was poor whereas at higher range the productivity was average. It was observed in the study period obviously Phosphorus in soil showed direct relationship with the productivity of biota in the sagar. Hepher (1958) obtained that the rapid active phosphate uptake by phytoplankton is not the main cause of the disappearance of the high concentration of phosphorus after fertilization. The principal reasons being adsorption by the bottom mud and chemical process in water resulting in phosphate precipitation.

Nitrogen :

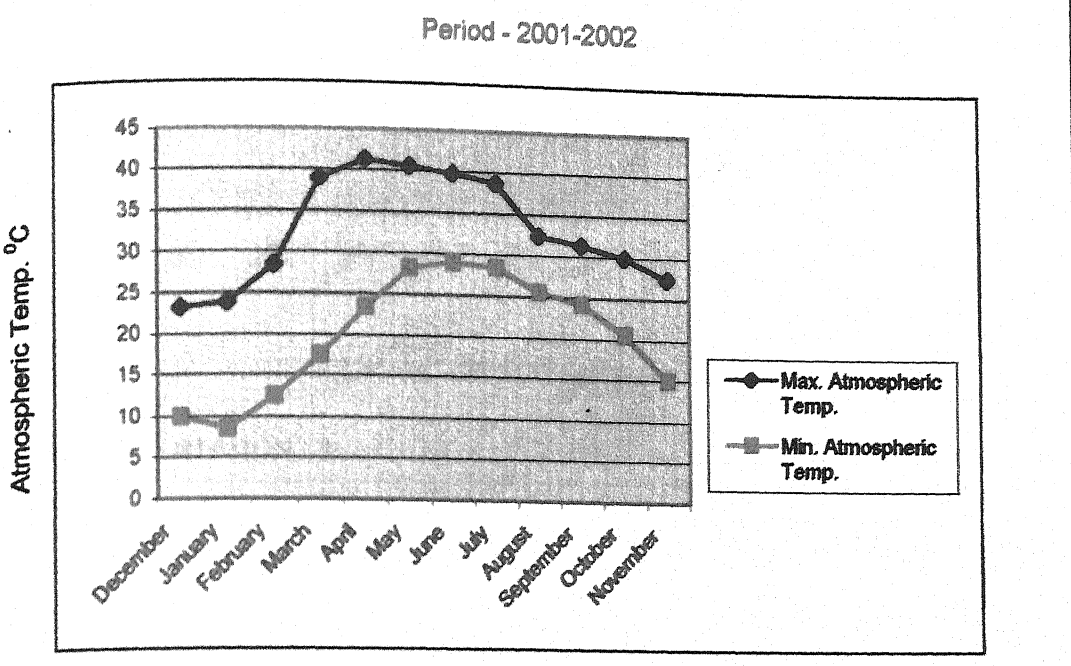
The soil is the main source of nitrogen supply to the pond through the decomposition of organic matter. The amount of nitrogen available to the pond is sufficient for growth of phytoplankton. Nitrogen fertilizers in the pond, in order to maintain a level of 1mg/l N 1 various factors influencing the nitrogen equilibrium in the pond and the methods to increase the nitrogen content in the water should be

thoroughly examined. Banerjea (1967) has attempted to co-relate fish production with the available nitrogen concentration in fresh water fish ponds. If, however, the number of productive ponds in diffrent ranges of nitrogen are considered, the range of 50 to 75 may be take as relatively more favourable for fish production (Banerjea, 1967). The role of nitrogen in soils of fish pond has been reviewed by Neess (1949) and Hepher (1952). The organic matter occurring on pond bottom is broken down by a number of micro organisms. The end products of this decomposition among others are Co_2, water and ammonia while ammonium salts were formed in a number of bacteria found in the soil and water convert ammonia nitrogen into nitrates. In the present study of Keerat sagar Nitrogen range from to 20 to 85ppm.. 20ppm. which was very low and 85ppm. which was high range. Which is considerable for fish production.

Potassium :

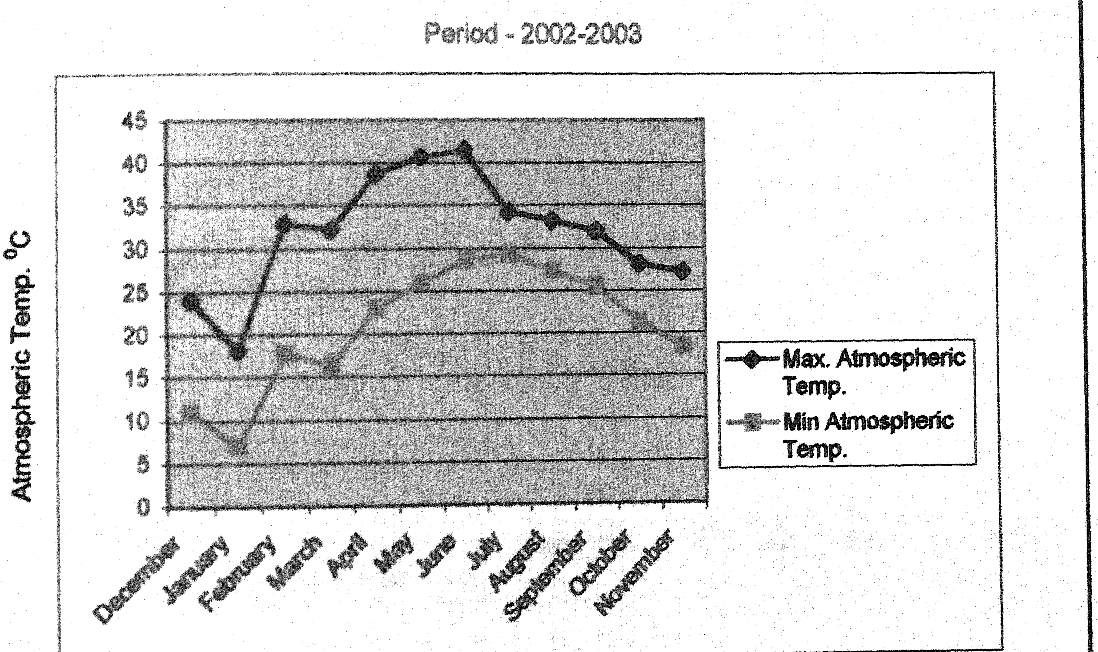
Potassium from soil is taken up readily by submerged weeds for growth, especially potamogeton, Myriophyllum, Ceratophyllum, etc. During rapid plant growth period potassium from the water and soil is stored in the tissues. Potassium from soil to water, a high hydration of soil colloiods is favourable and for that reason, there is never a total absence of this nutrient in ponds. Schaperclaus (1961) stated that potassium is odsorved in the mud during winter and released during summer.

In the present study of Keerat sagar potassium ranged from 50 to 255 ppm. These range of potassium suitable for the growth of aquatic weeds and algae. Excessive growth of weeds adversely effects the fish productivity in the sagar. Hence indirect relationship was observed.



Monthly Atmospheric Temp. in Mahoba

Fig. -2



Monthly Atmospheric Temp. in Mahoba

Fig. -3

Period - 2001-2002

Water Temperature in ^0C

STATION - A

Water Temp.

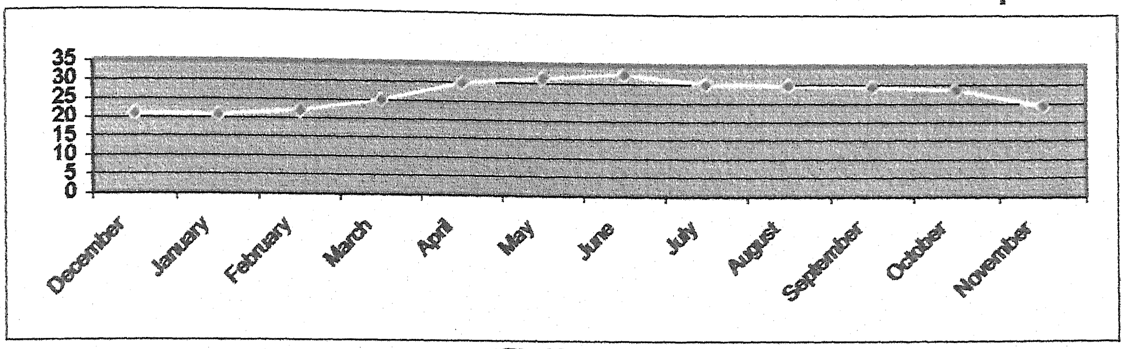


Fig No. 4

STATION - B

Water Temp.

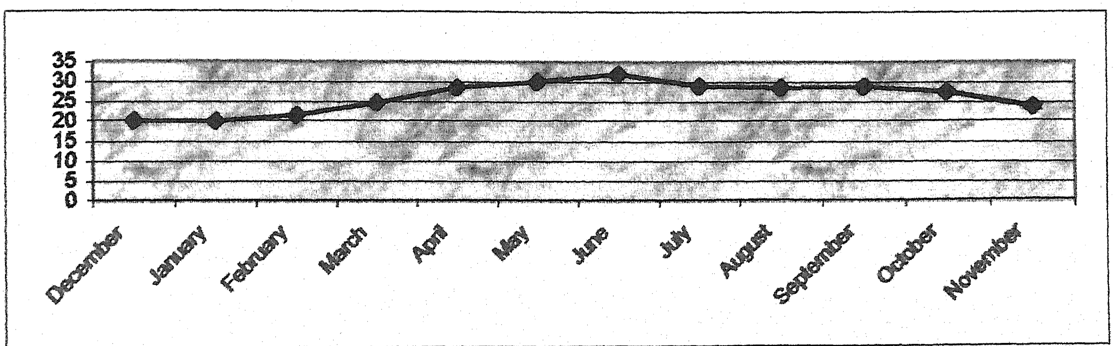


Fig No. 5

STATION - C

Water Temp.

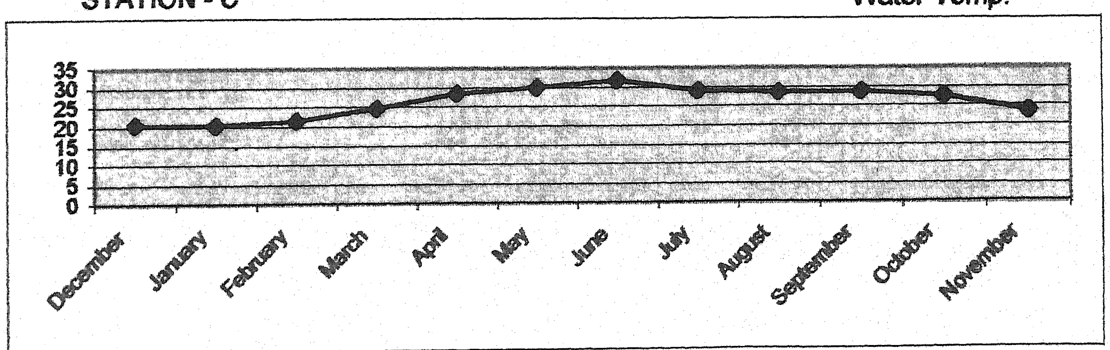


Fig No. 6

STATION - D

Water Temp.

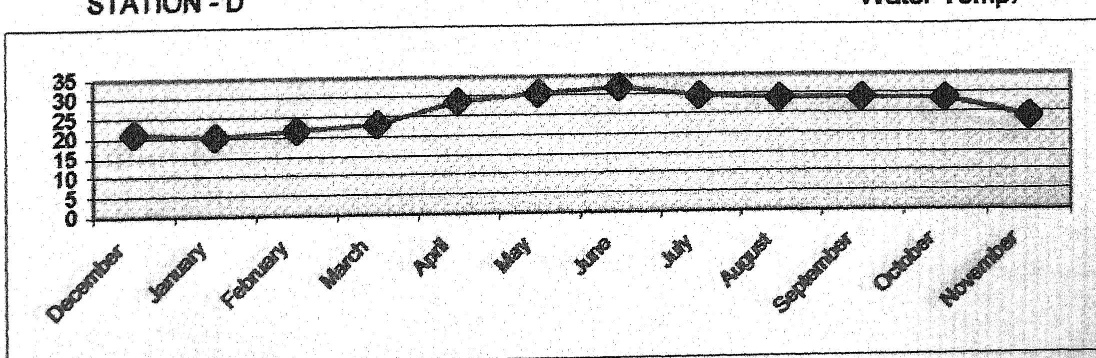


Fig No. 7

Period - 2002-2003

Water Temperature in ^0C

STATION - A Water Temp.

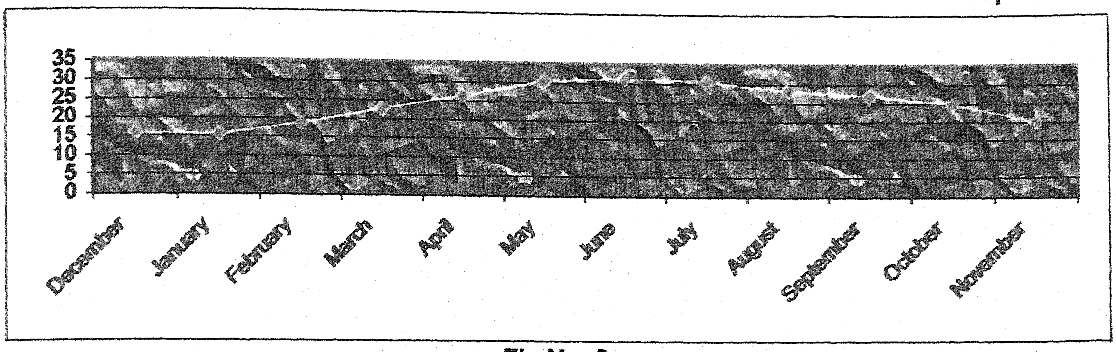


Fig No. 8

STATION - B Water Temp.

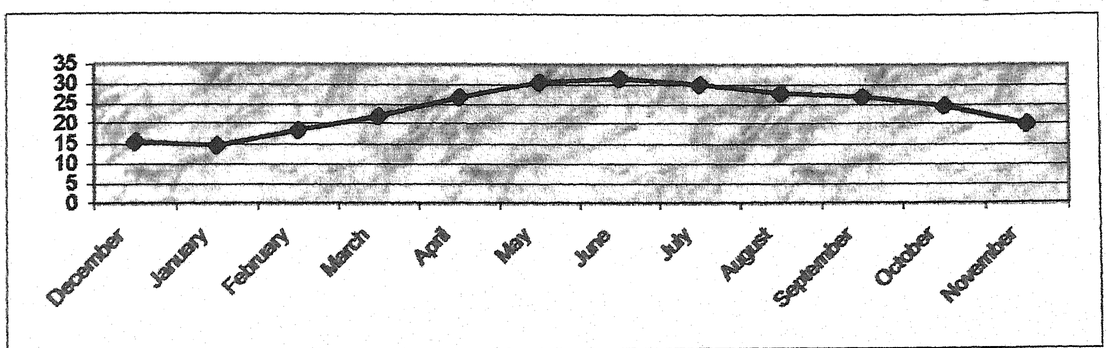


Fig No. 9

STATION - C Water Temp.

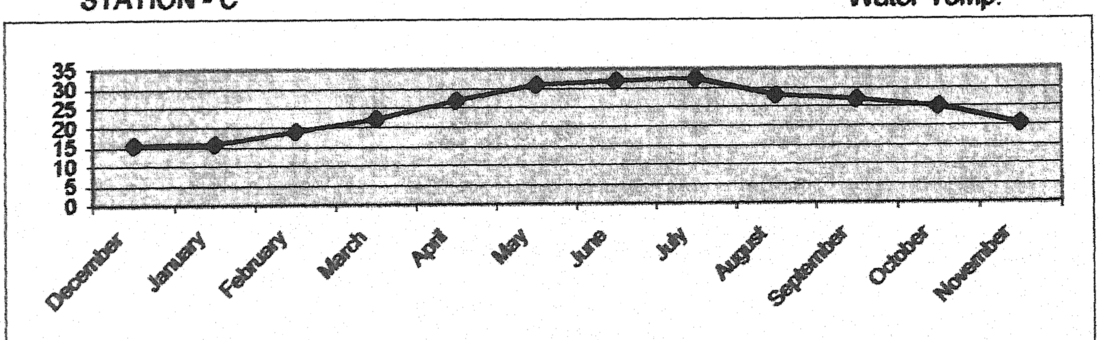


Fig No. 10

STATION - D Water Temp.

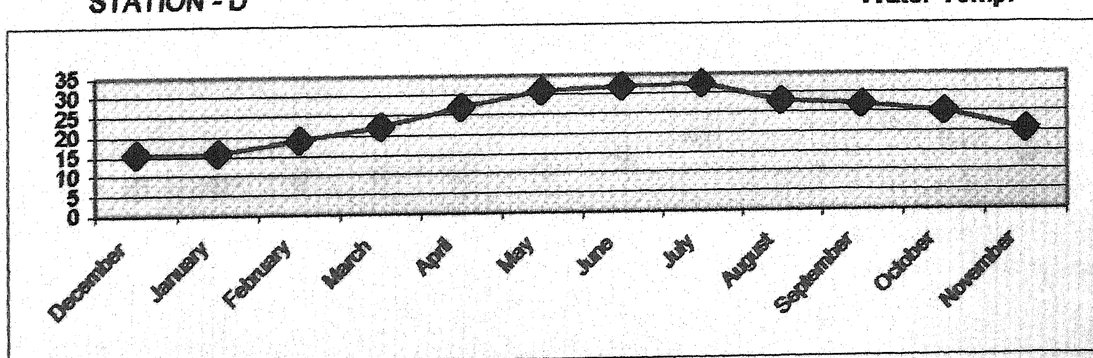


Fig No. 11

Period - 2001-2002

Turbidity in N.T.U

STATION - A

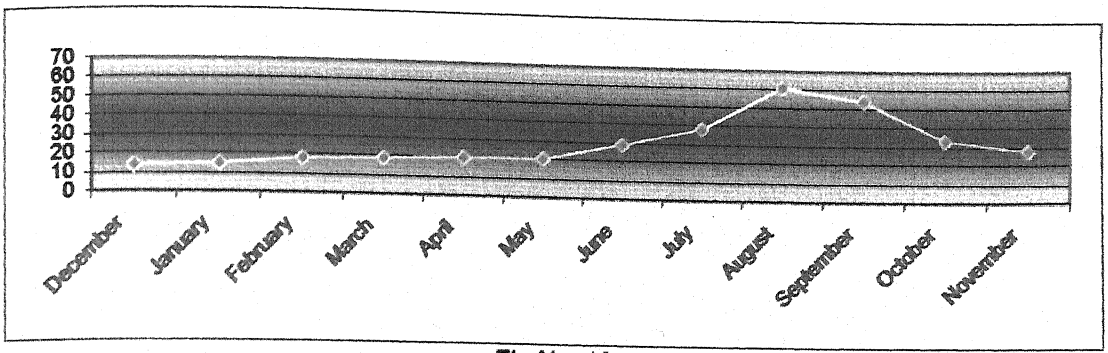


Fig No. 12

STATION - B

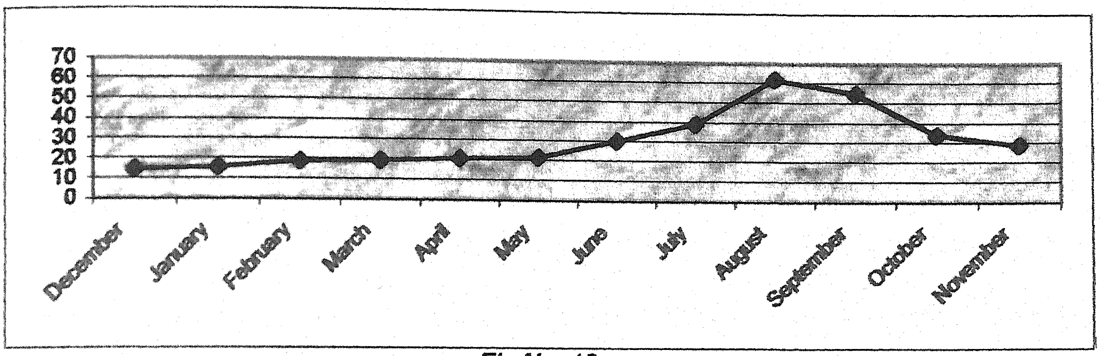


Fig No. 13

STATION - C

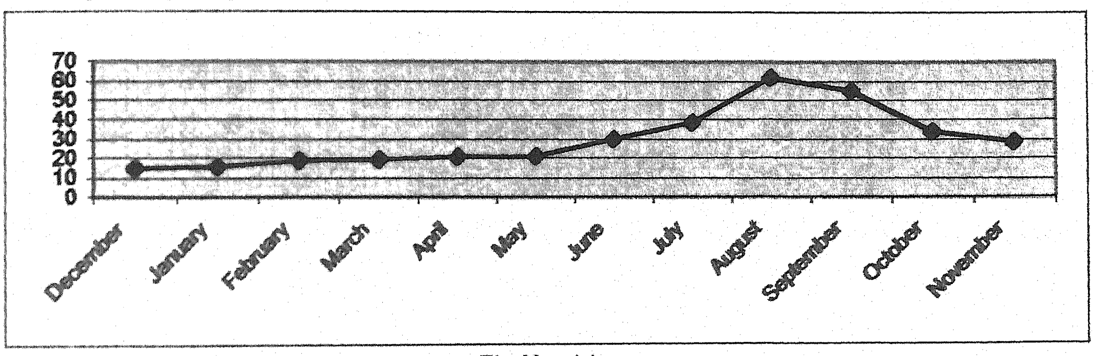


Fig No. 14

STATION - D

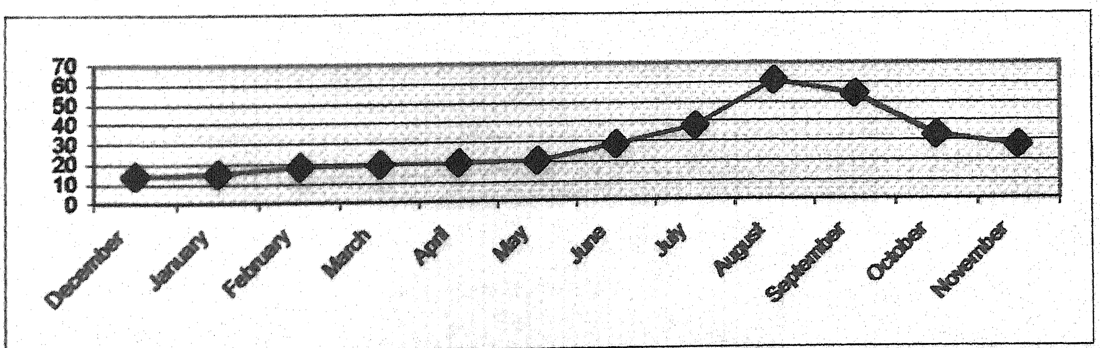


Fig No. 15

Period - 2002-2003

Turbidity N.T.U.

STATION - A

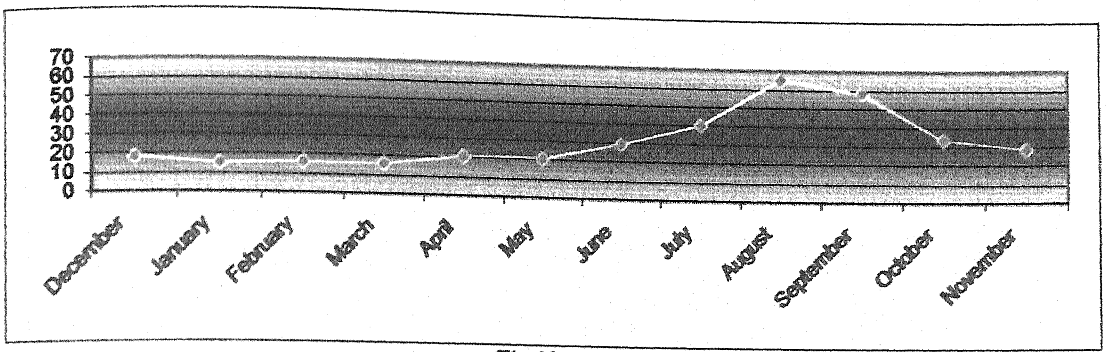


Fig No. 16

STATION - B

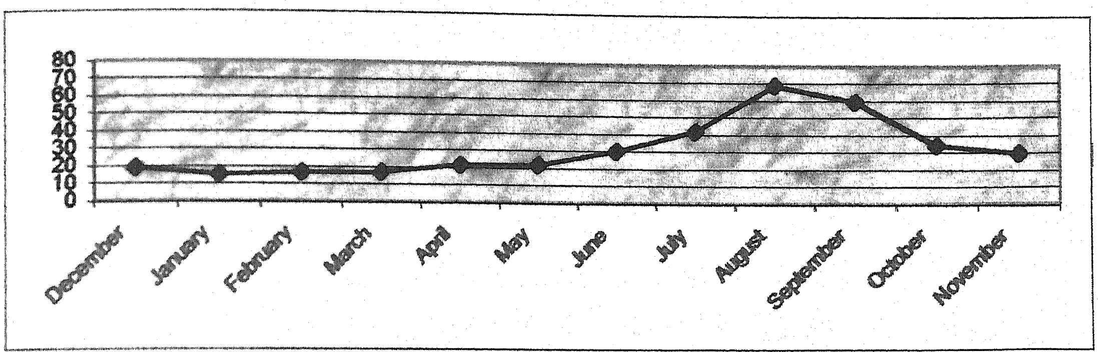


Fig No. 17

STATION - C

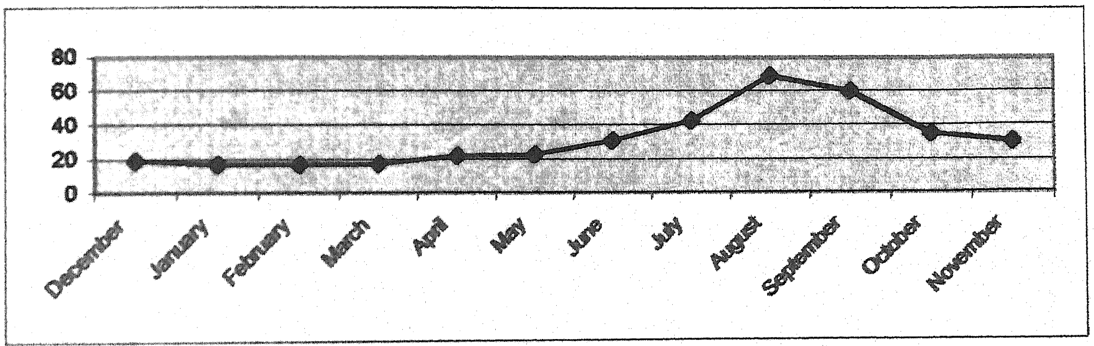


Fig No. 18

STATION - D

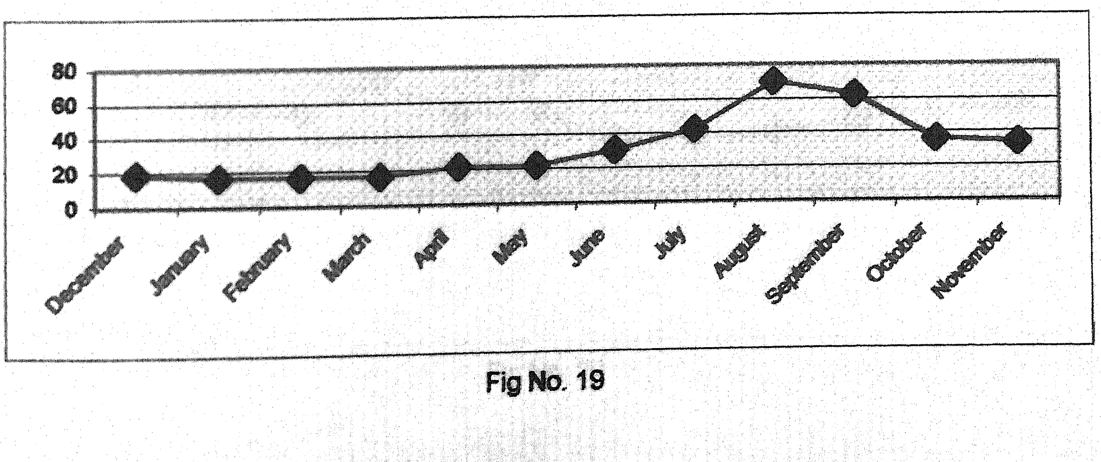


Fig No. 19

Period - 2001-2002

Hydrogen-ion concentration in pH

STATION - A

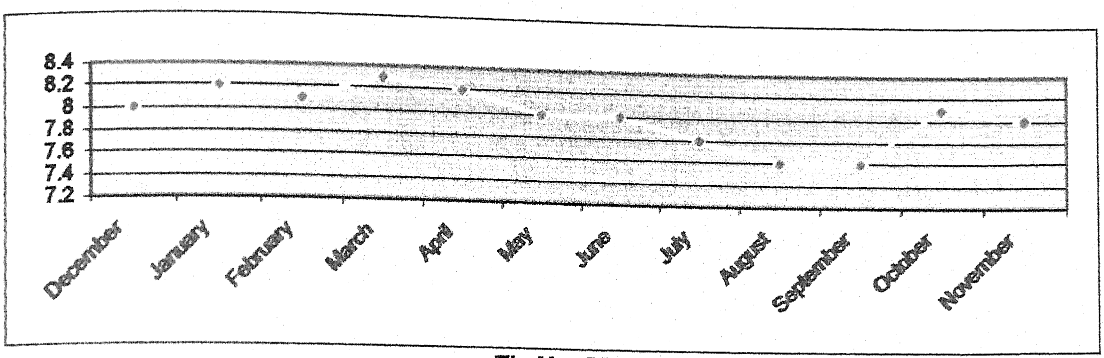


Fig No. 20

STATION - B

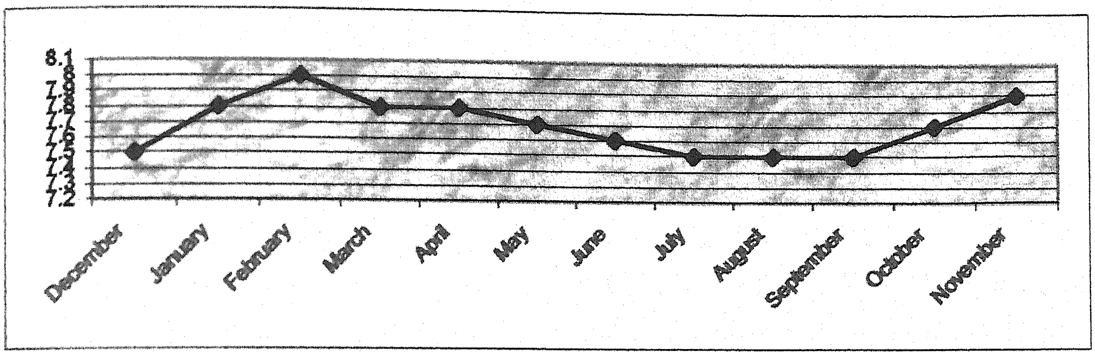


Fig No. 21

STATION - C

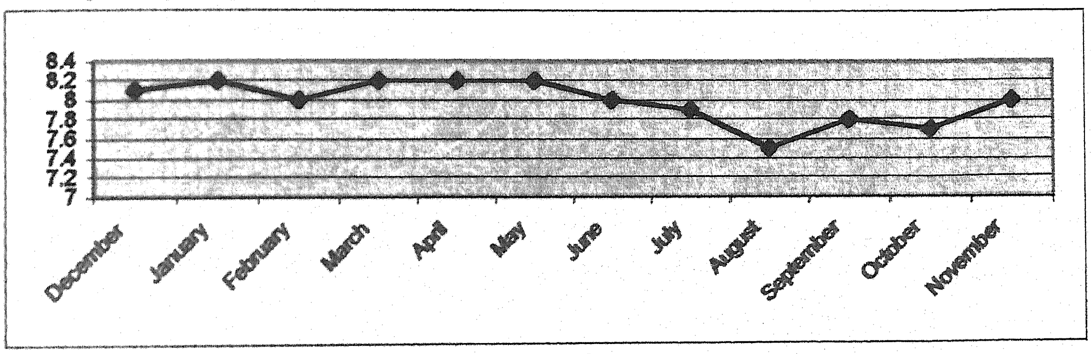


Fig No. 22

STATION - D

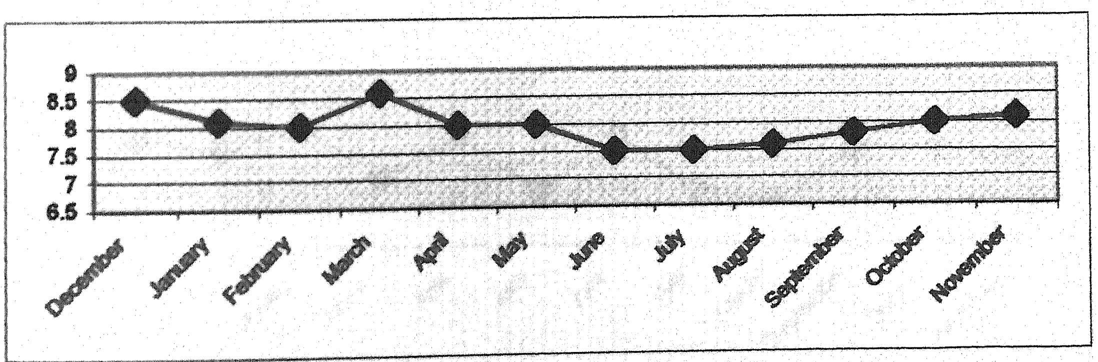


Fig No. 23

Period - 2002-2003

Hydrogen-ion concentration in pH.

STATION - A

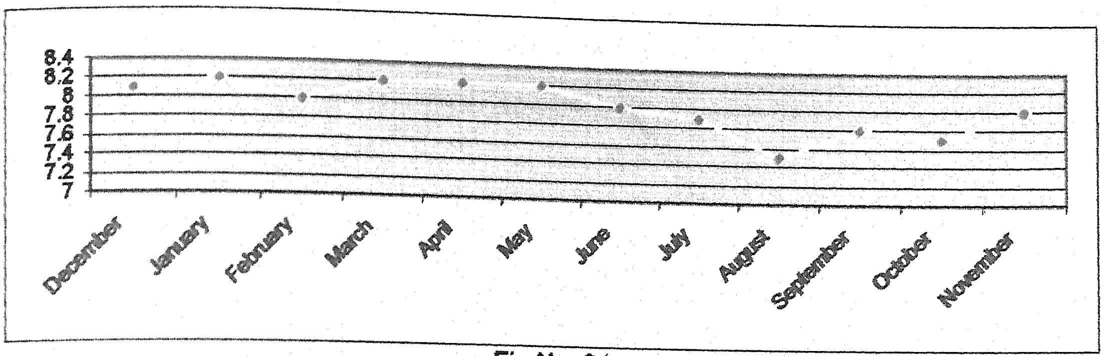


Fig No. 24

STATION - B

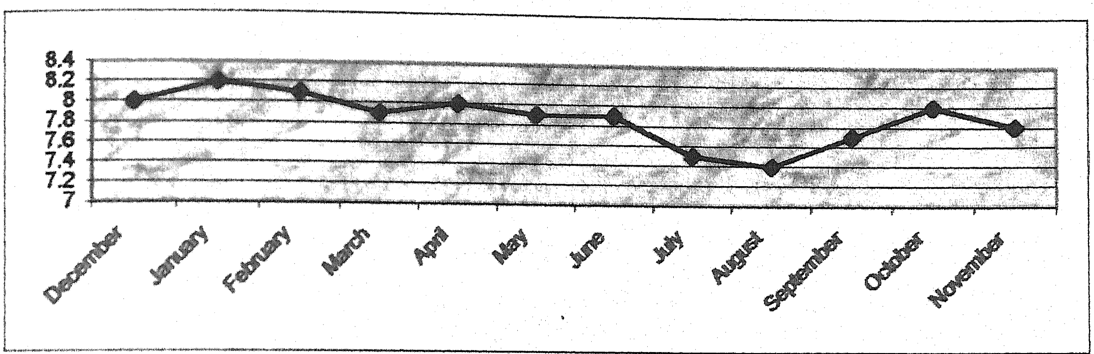


Fig No. 25

STATION - C

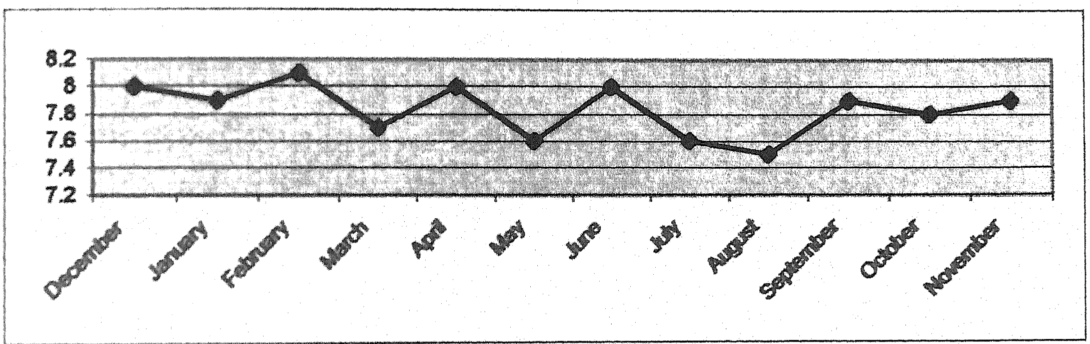


Fig No. 26

STATION - D

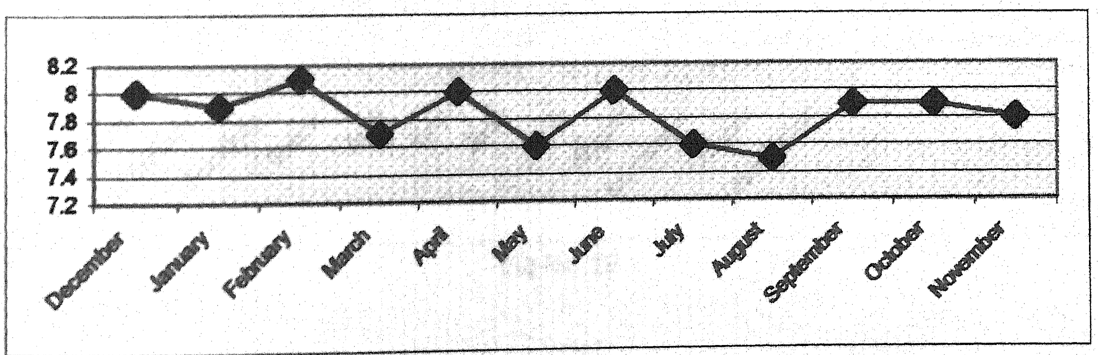


FIG NO. 27

Period - 2001-2002

STATION - A

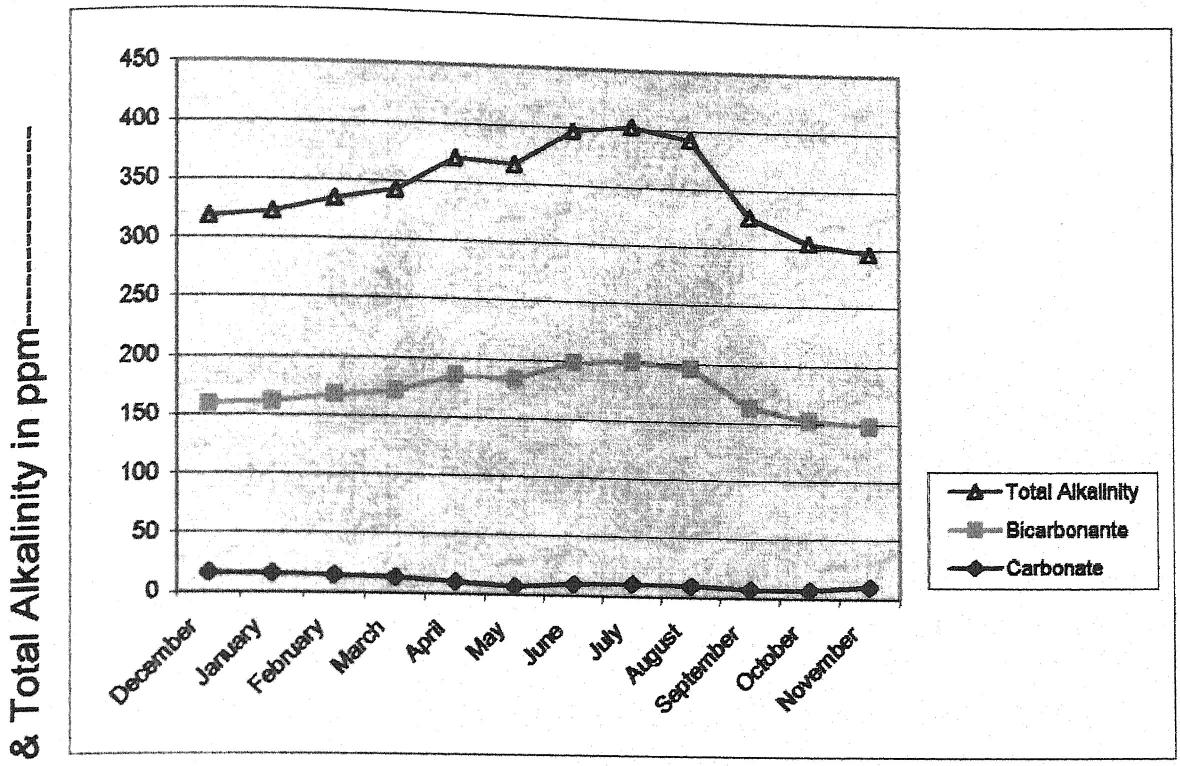


Fig No. 28

STATION - B

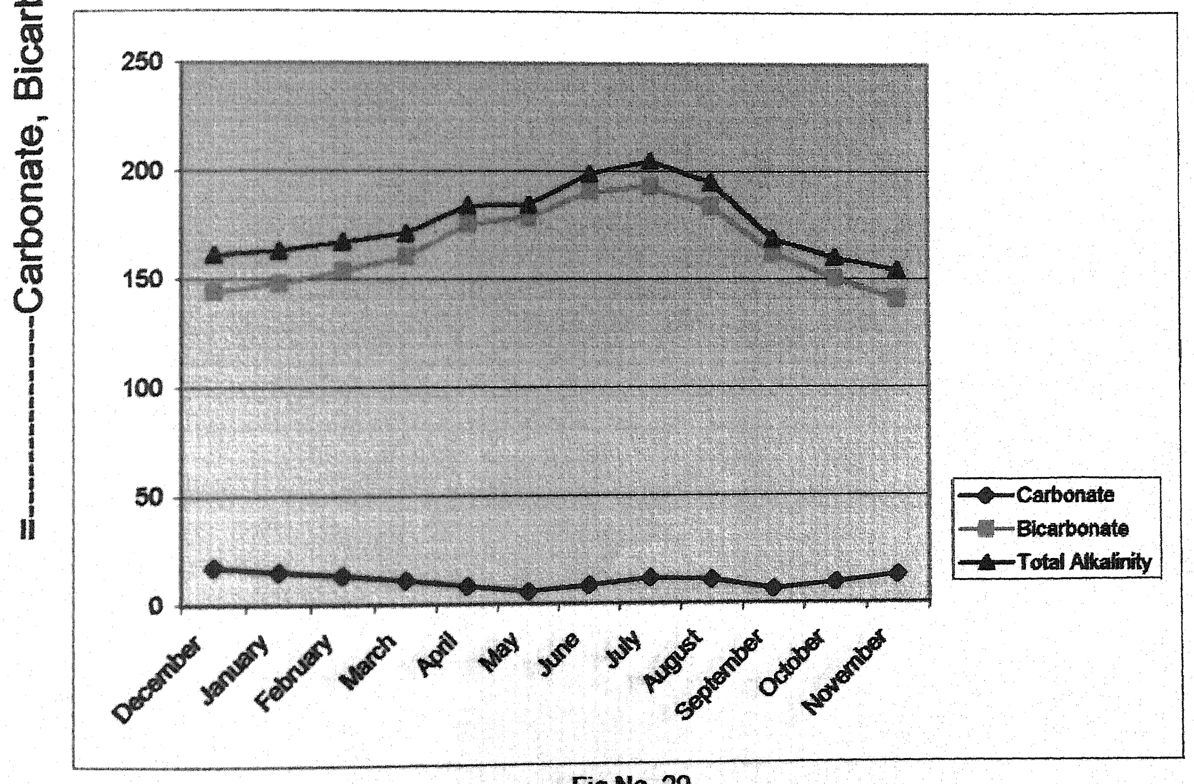


Fig No. 29

Period - 2001-2002

Carbonate, Bicarbonate & Total Alkalinity in ppm

STATION - C

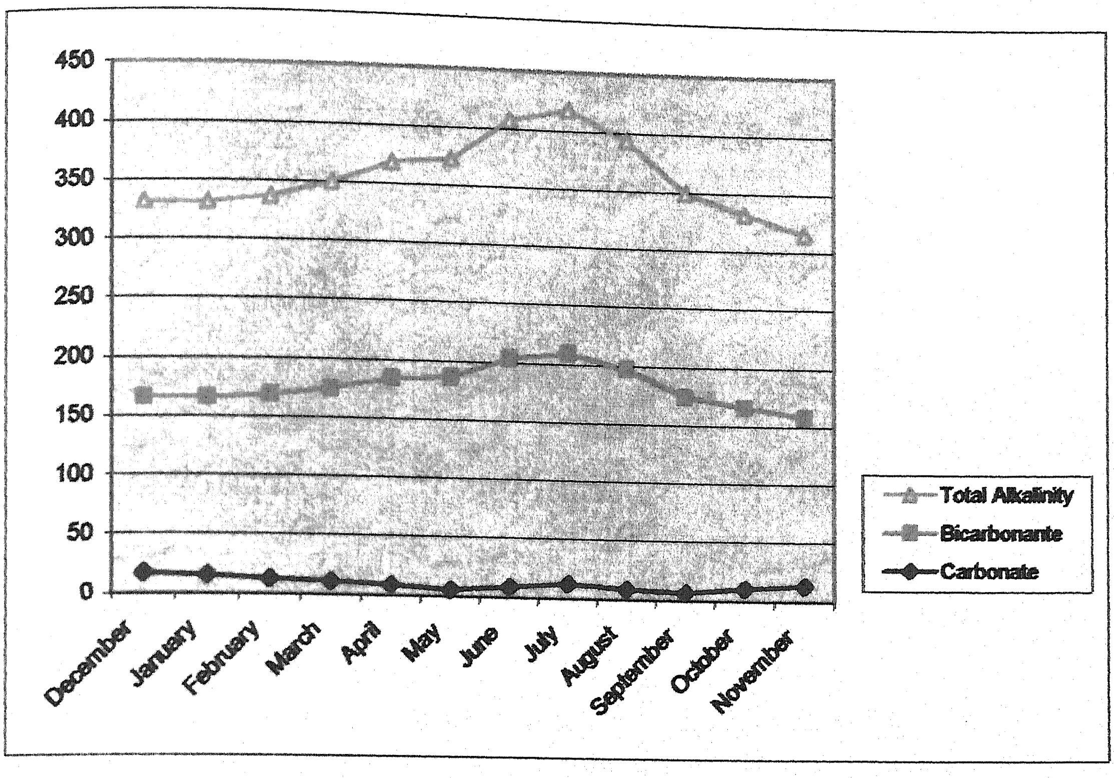


Fig No. 30

STATION - D

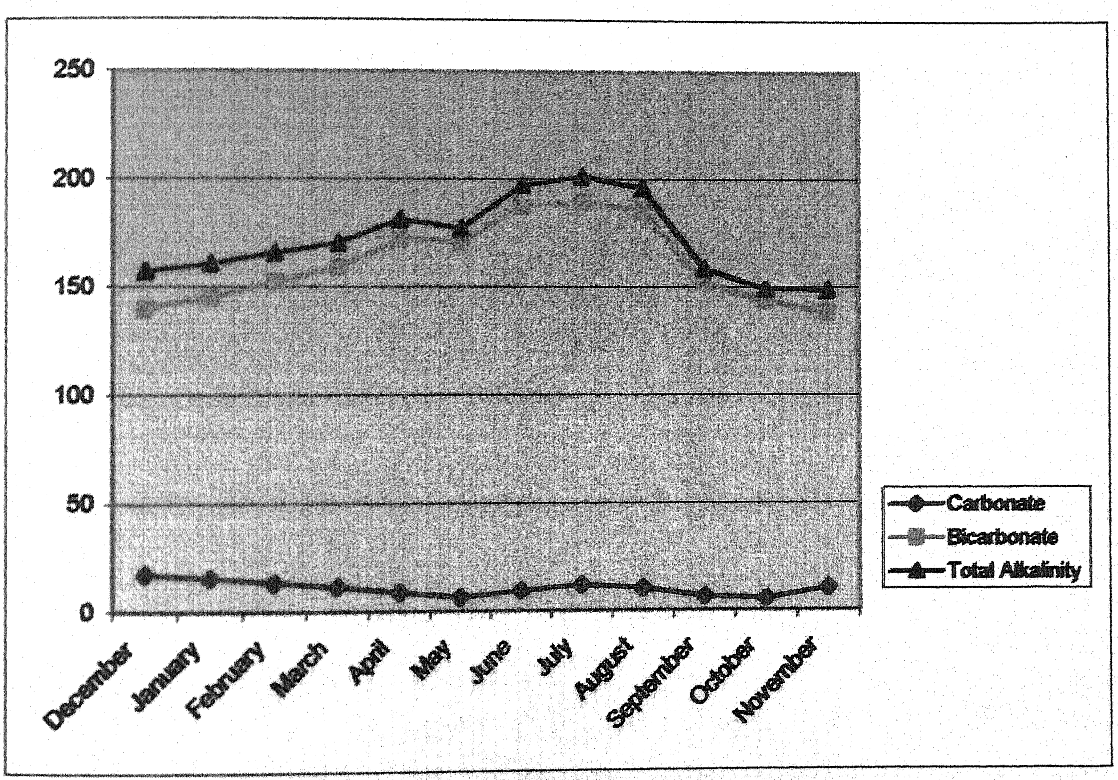


Fig No. 31

Period - 2002-2003

STATION - A

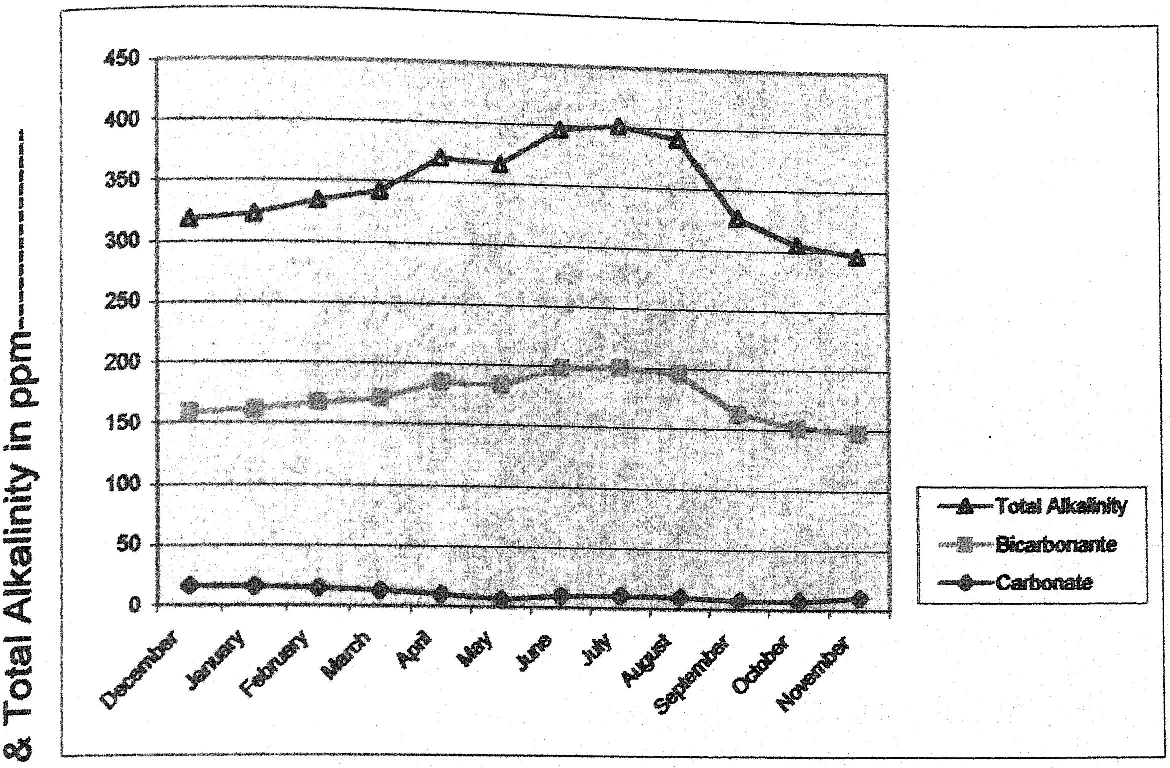


Fig No. 32

STATION - B

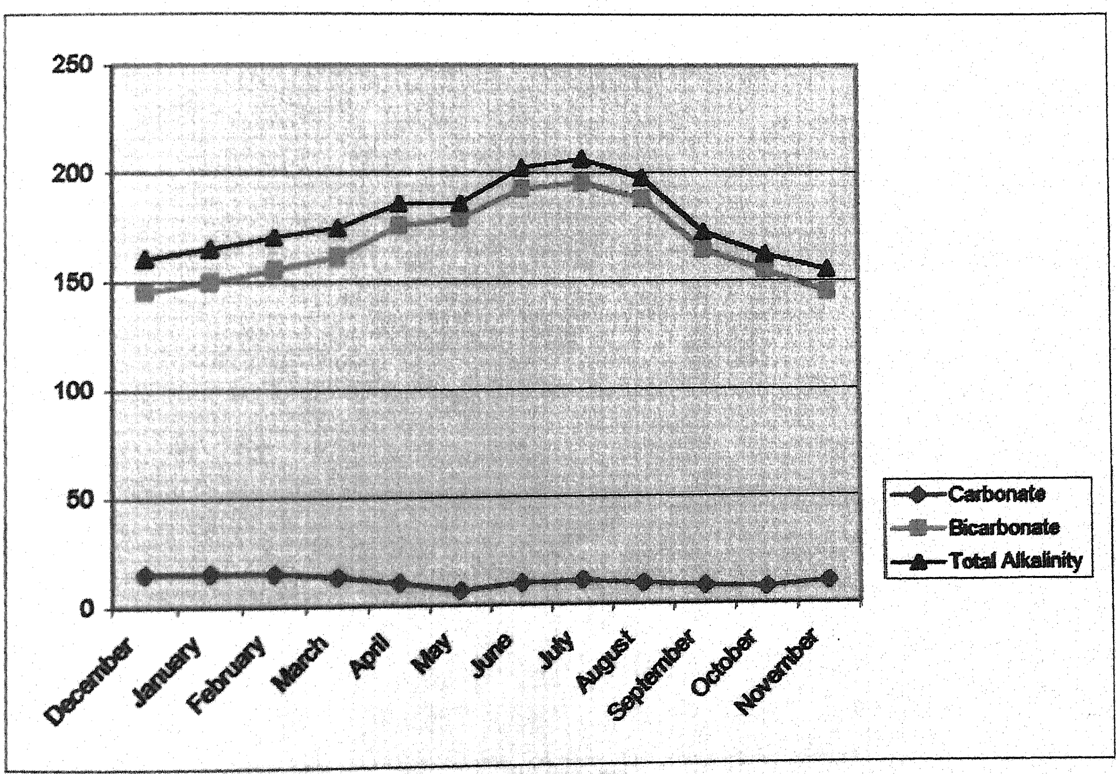


Fig No. 33

Period - 2002-2003

STATION - C

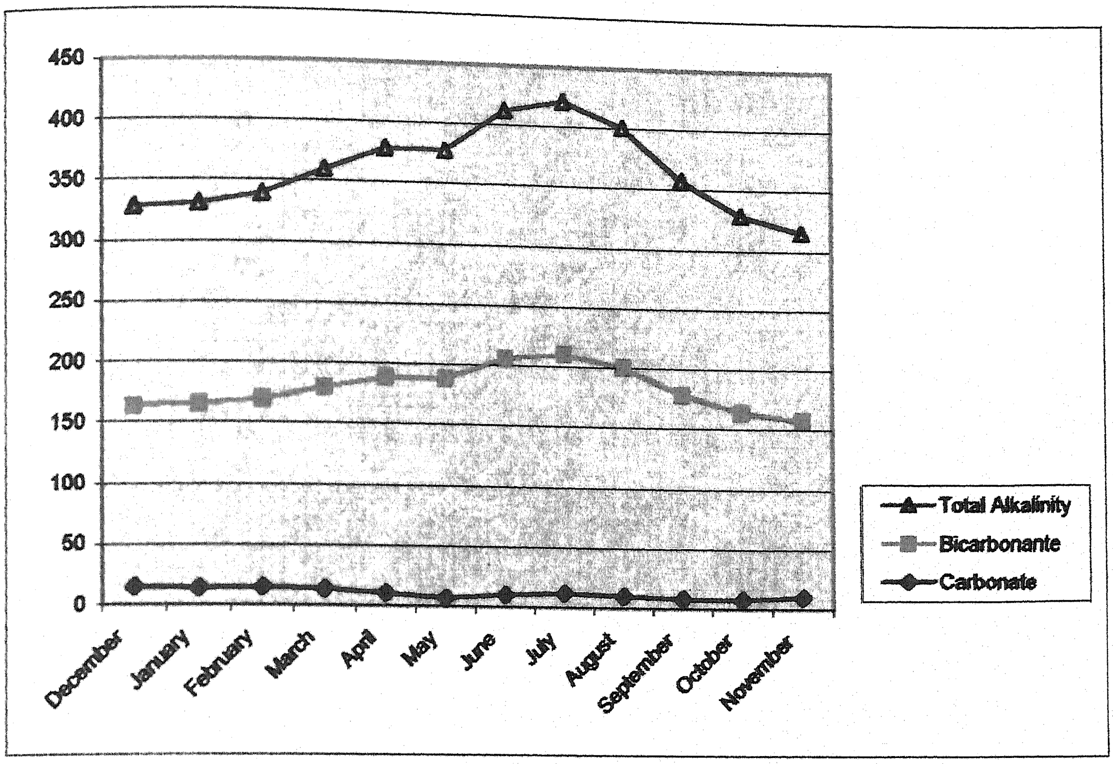


Fig No. 34

STATION - D

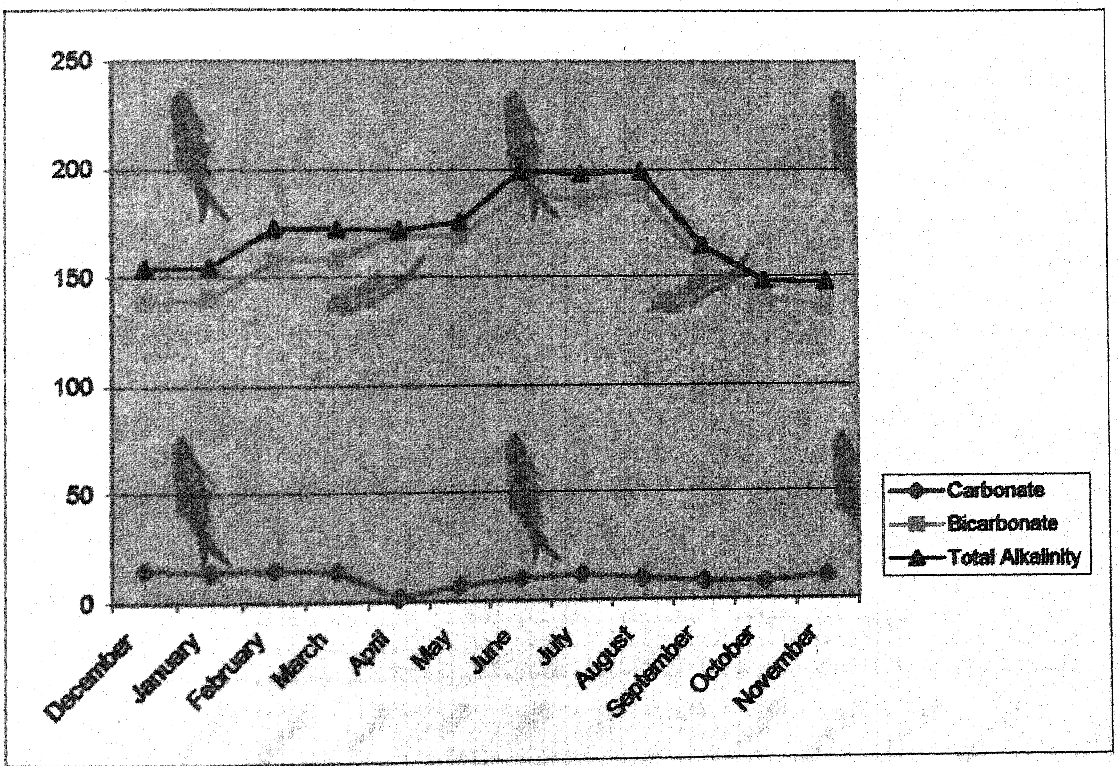


Fig No. 35

—Carbonate, Bicarbonate & Total Alkalinity in ppm—

Period - 2001-2002

Chloride in ppm.

STATION - A

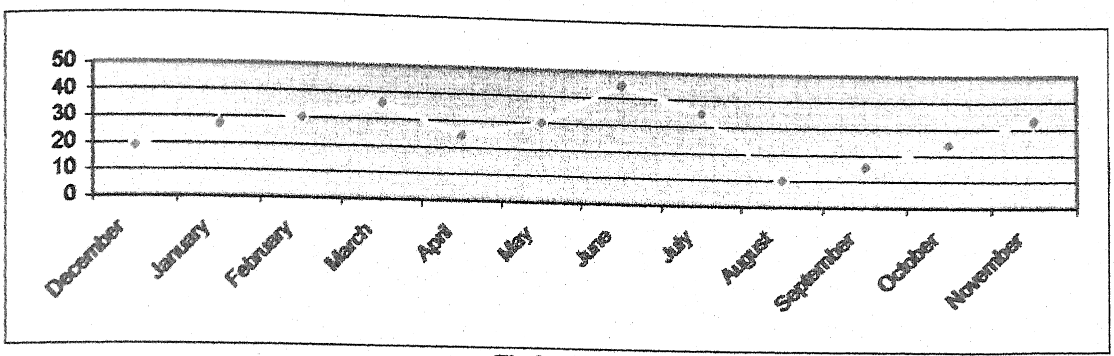


Fig No. 36

STATION - B

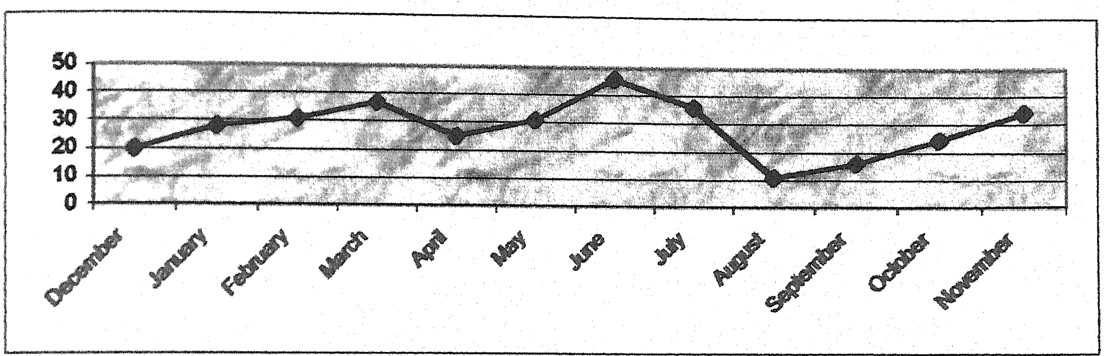


Fig No. 37

STATION - C

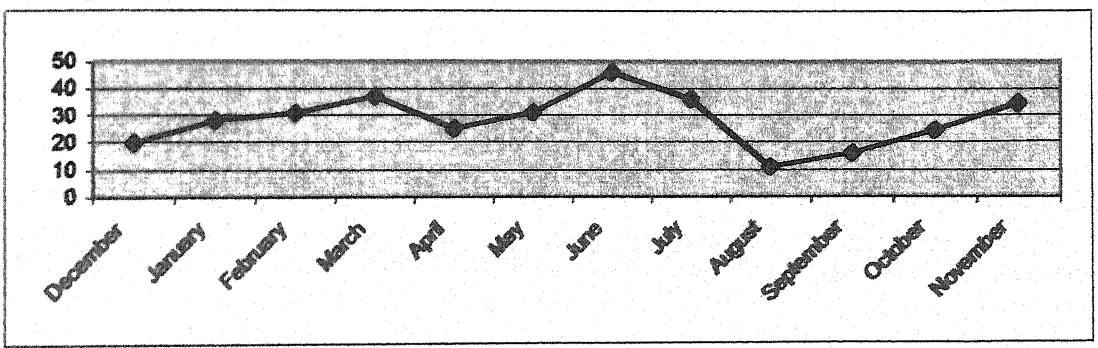


Fig No. 38

STATION - D

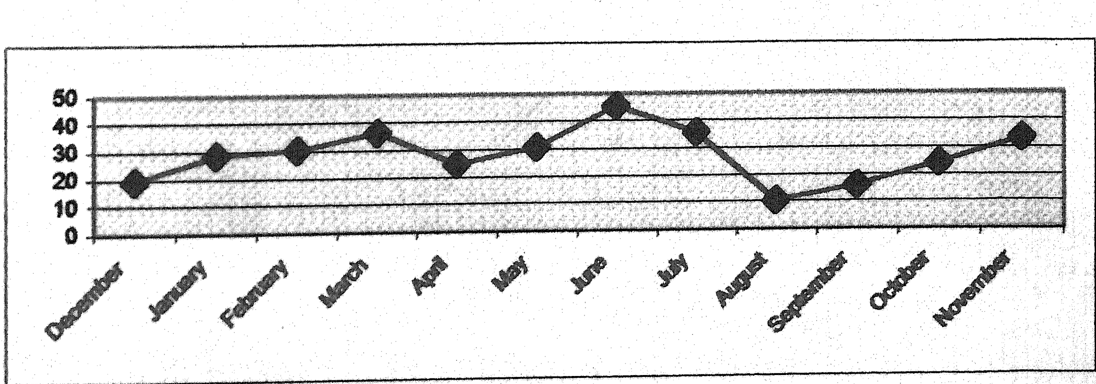


Fig No. 39

Period - 2002-2003

Chloride in ppm.

STATION - A

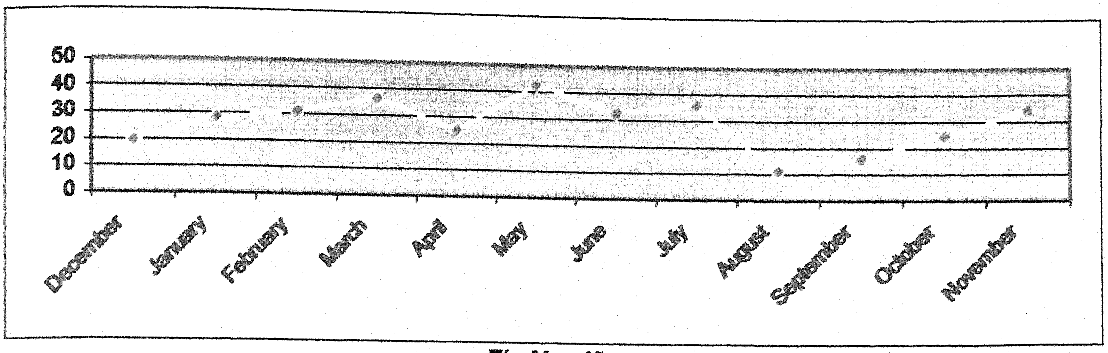


Fig No. 40

STATION - B

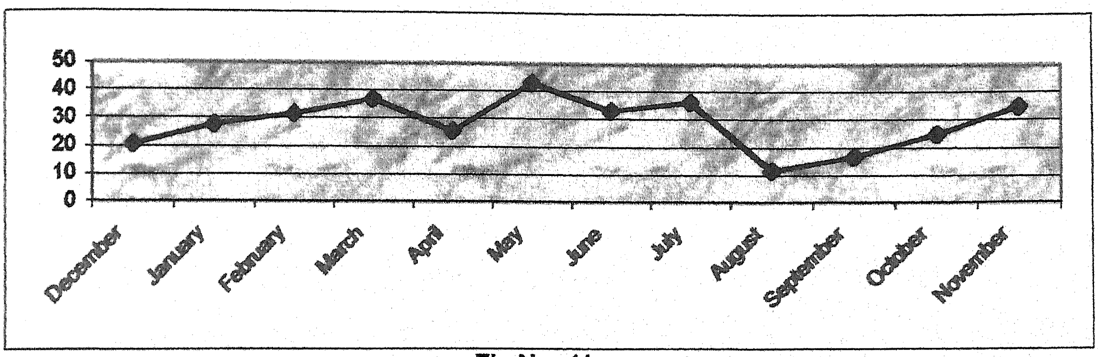


Fig No. 41

STATION - C

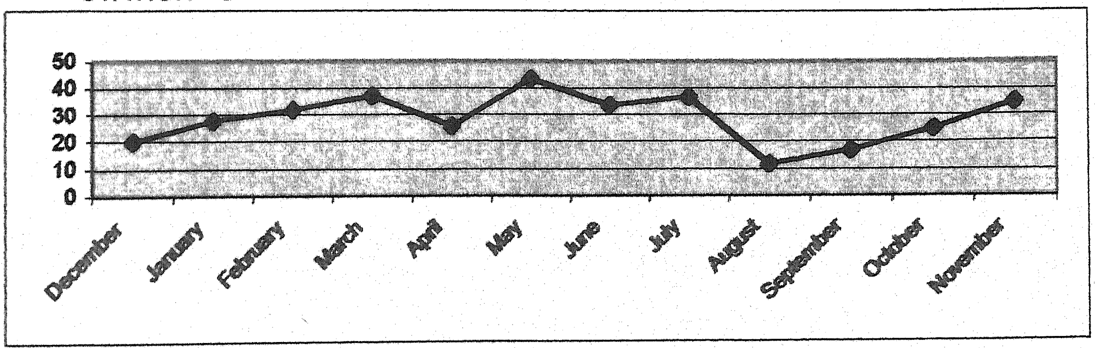


Fig No. 42

STATION - D

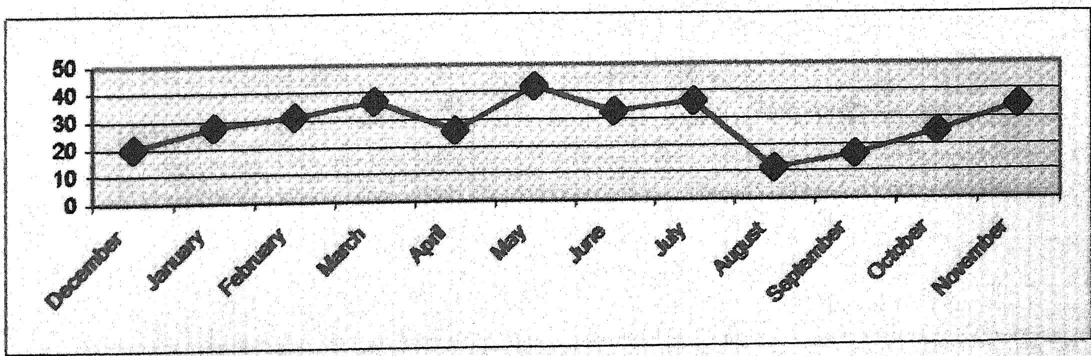


Fig No. 43

Period - 2001-2002

STATION - A

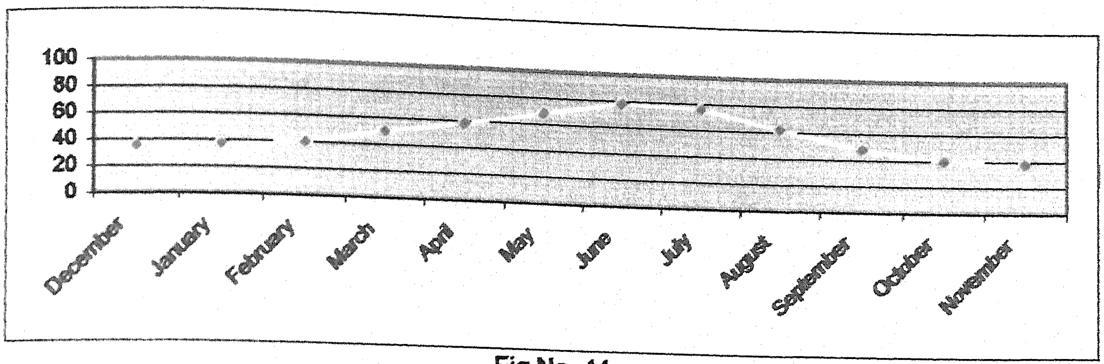


Fig No. 44

STATION - B

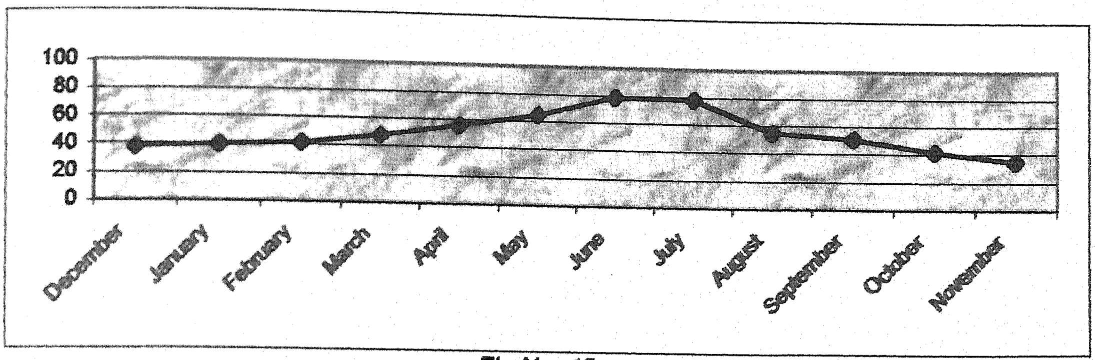


Fig No. 45

STATION - C

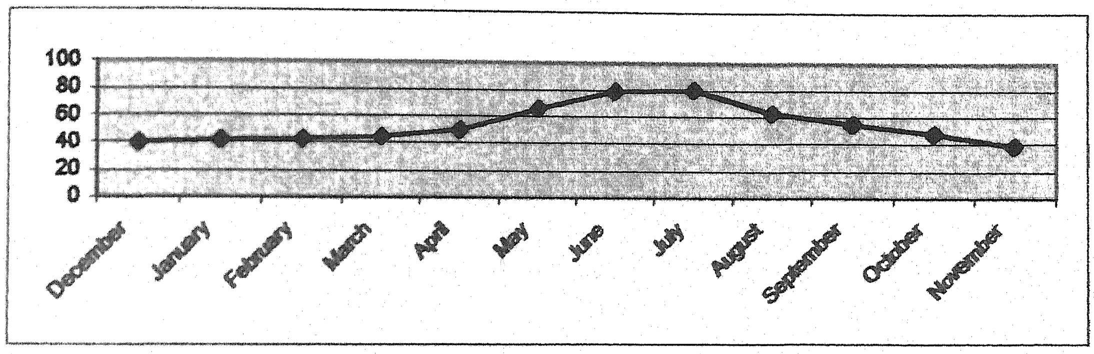


Fig No. 46

STATION - D

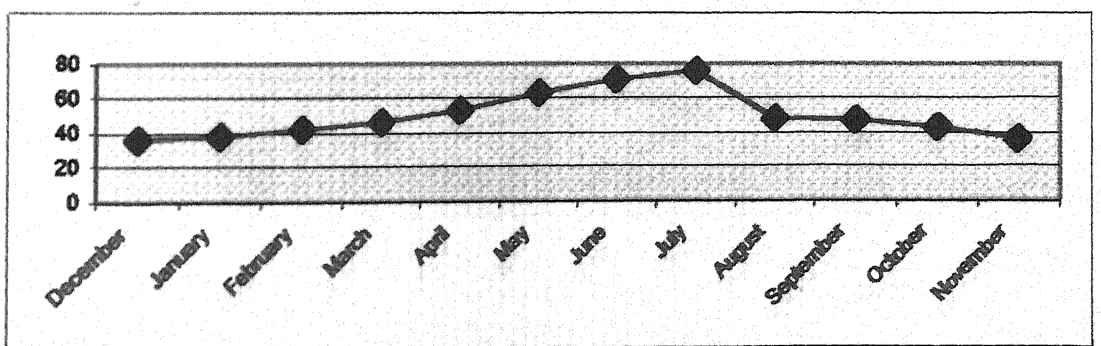


Fig No. 47

Ammonical Nitrogen in ppm

Period - 2002-2003

STATION - A

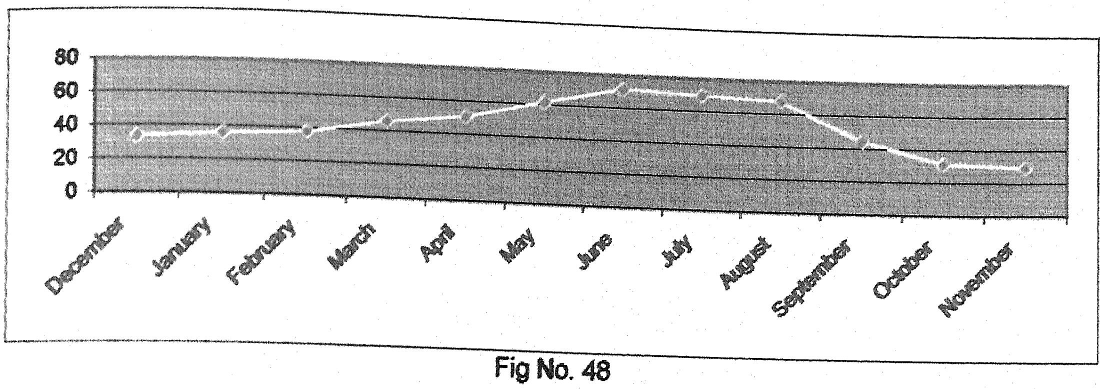


Fig No. 48

STATION - B

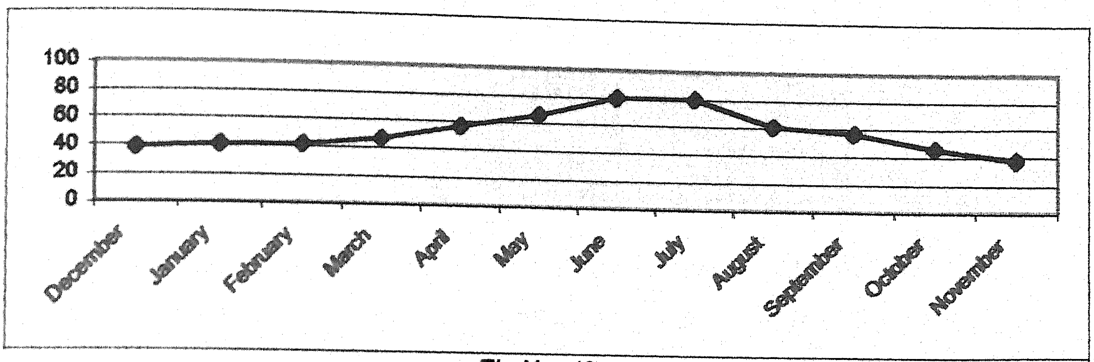


Fig No. 49

STATION - C

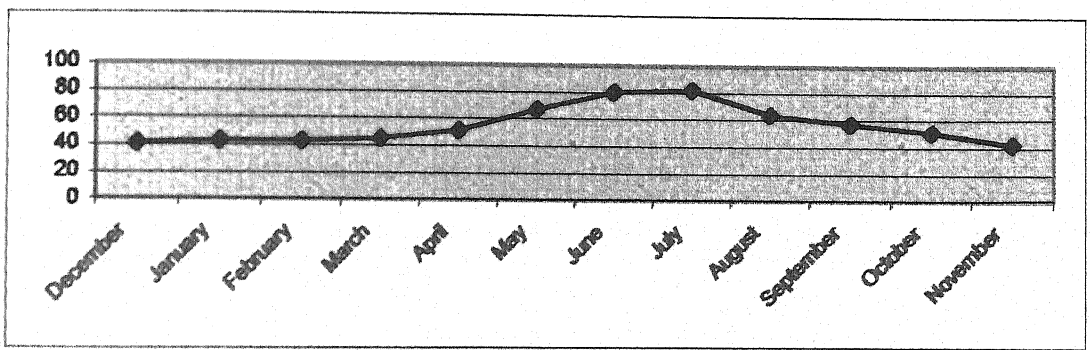


Fig No. 50

STATION - D

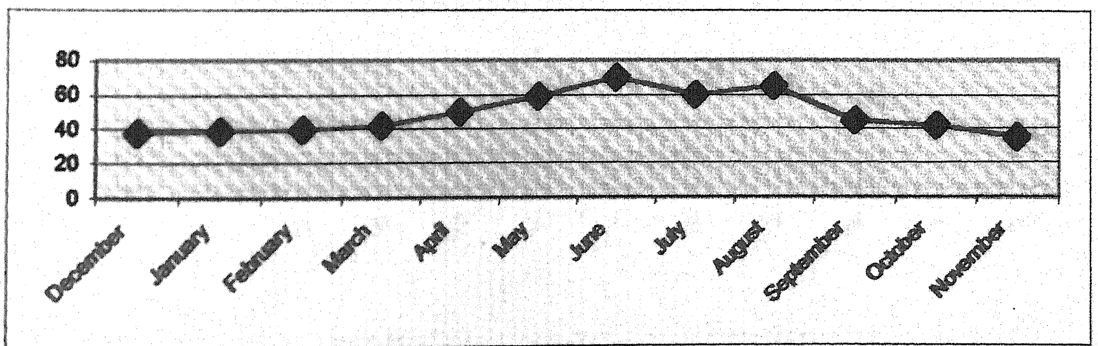


Fig No. 51

Ammonical Nitrogen in ppm

Period - 2001-2002

Phosphate in ppm

STATION - A

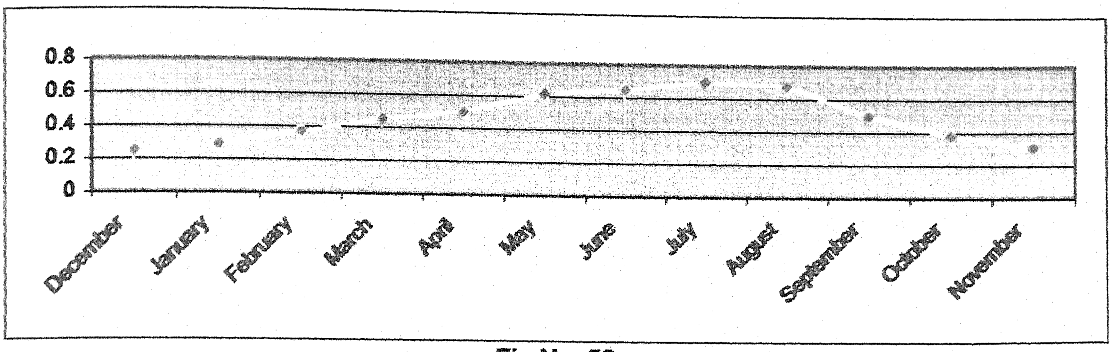


Fig No. 52

STATION - B

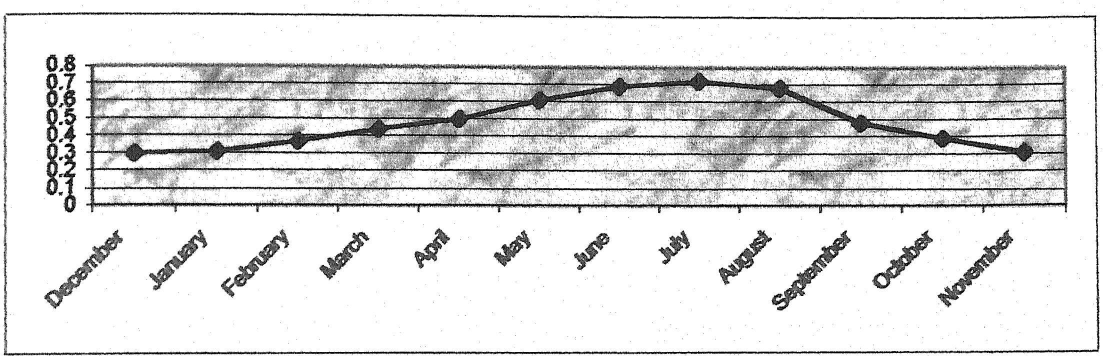


Fig No. 53

STATION - C

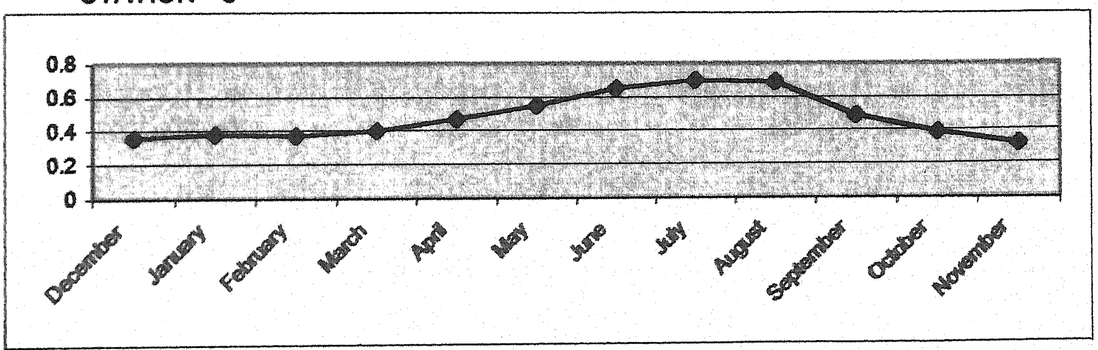


Fig No. 54

STATION - D

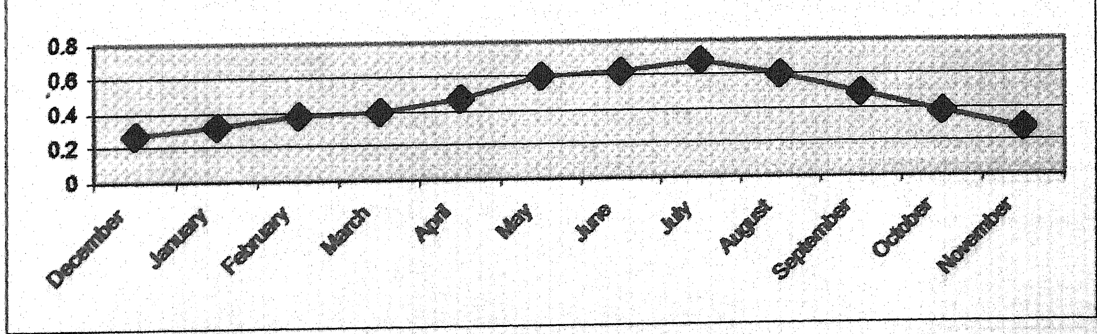


Fig No. 55

Period - 2002-2003

Phosphate in ppm

STATION - A

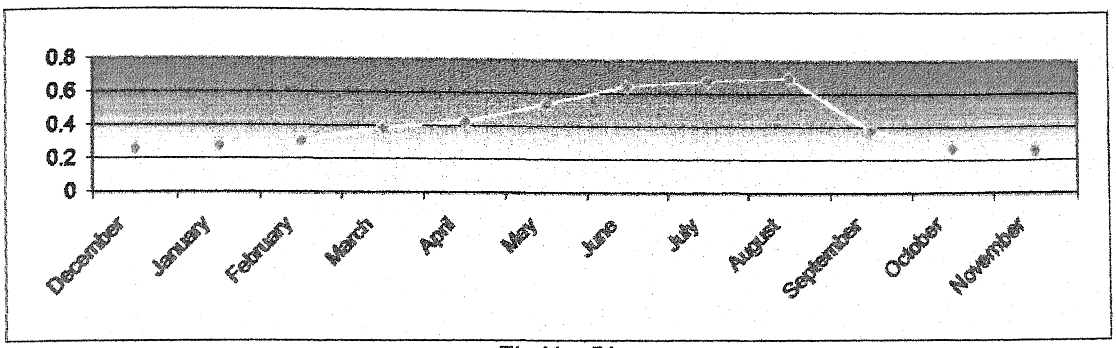


Fig No. 56

STATION - B

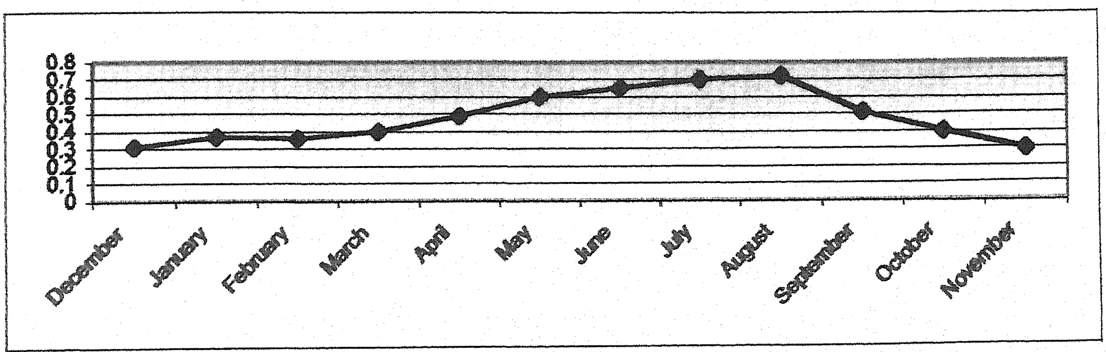


Fig No. 57

STATION - C

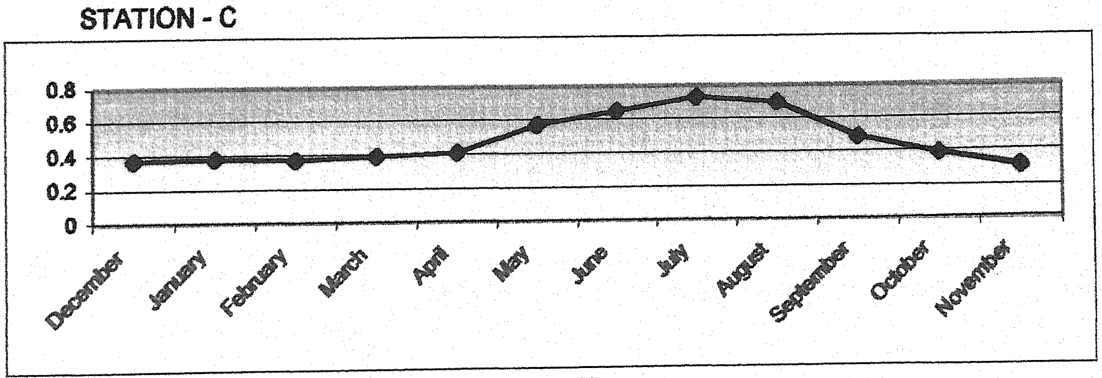


Fig No. 58

STATION - D

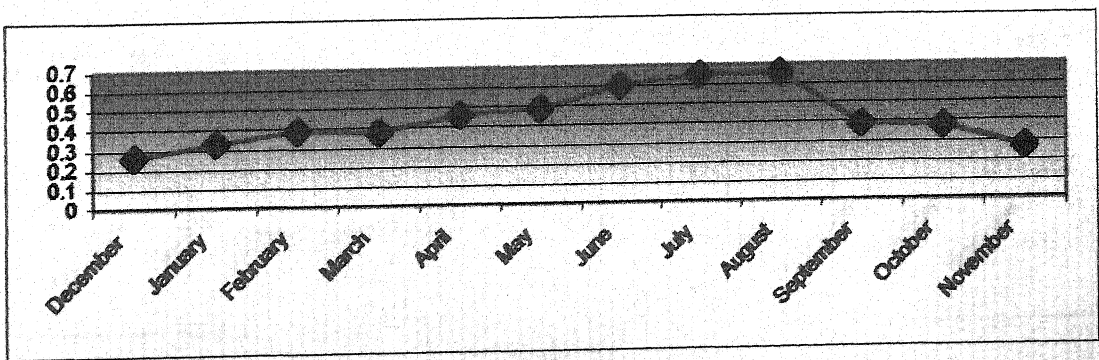


Fig No. 59

Period - 2001-2002

STATION - A

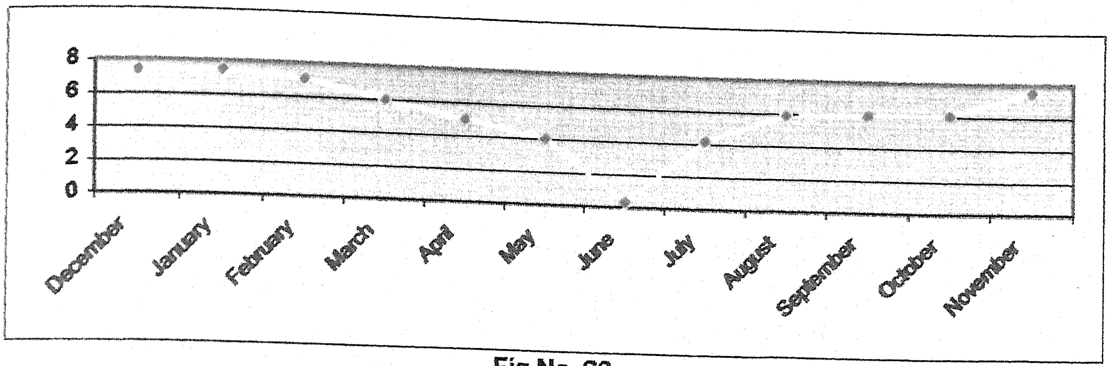


Fig No. 60

STATION - B

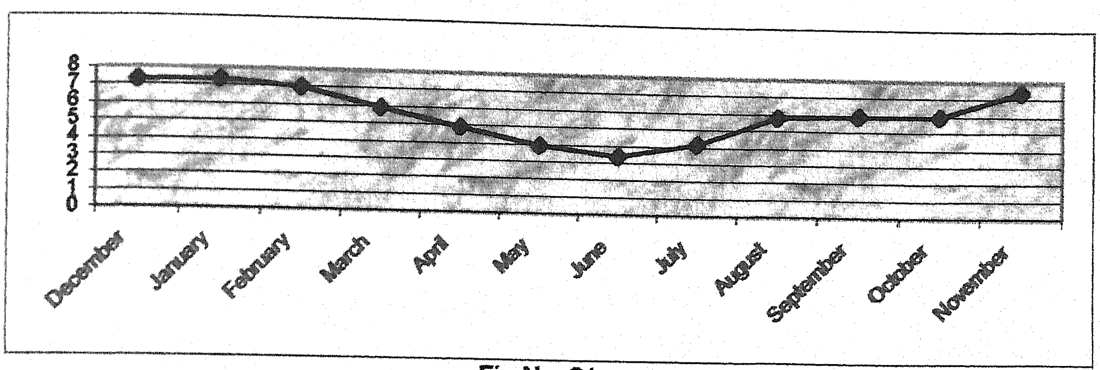


Fig No. 61

STATION - C

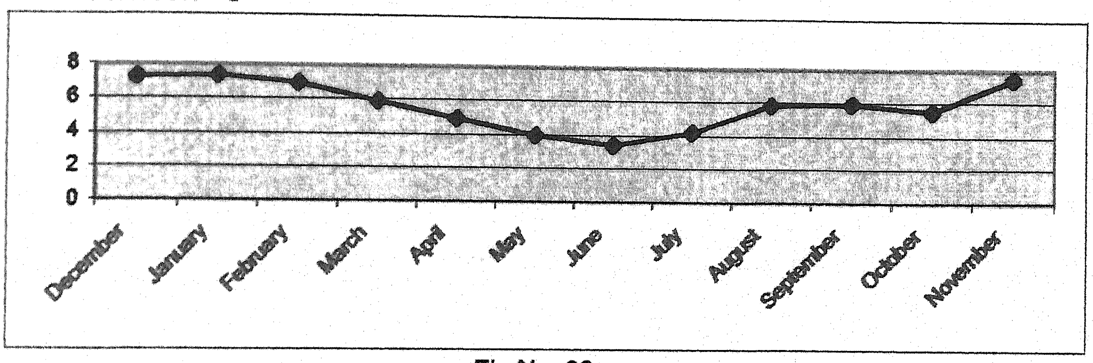


Fig No. 62

STATION - D

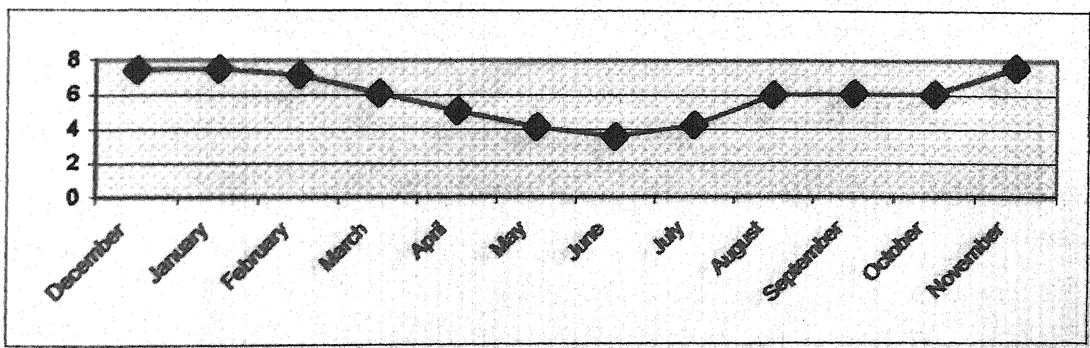


Fig No. 63

Period - 2002-2003

Dissolved oxygen in ppm

STATION - A

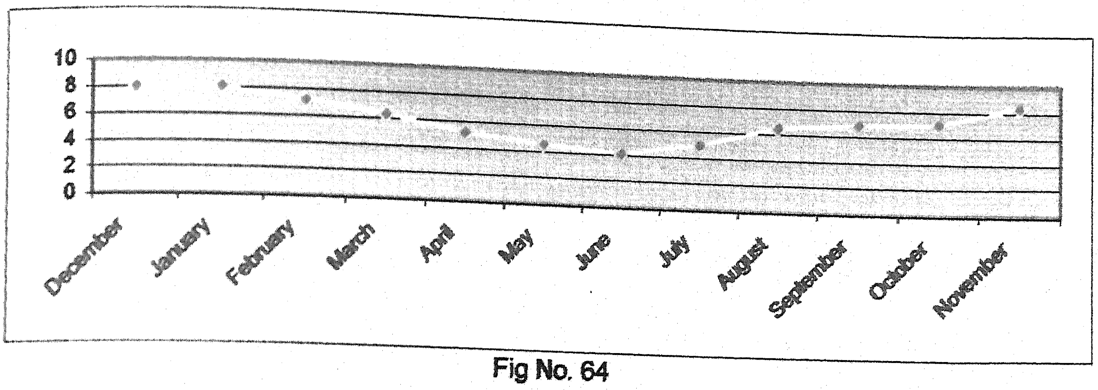


Fig No. 64

STATION - B

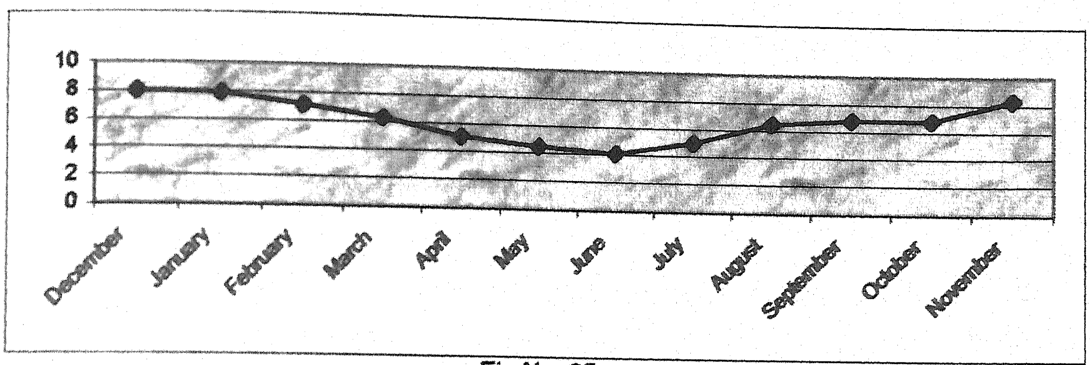


Fig No. 65

STATION - C

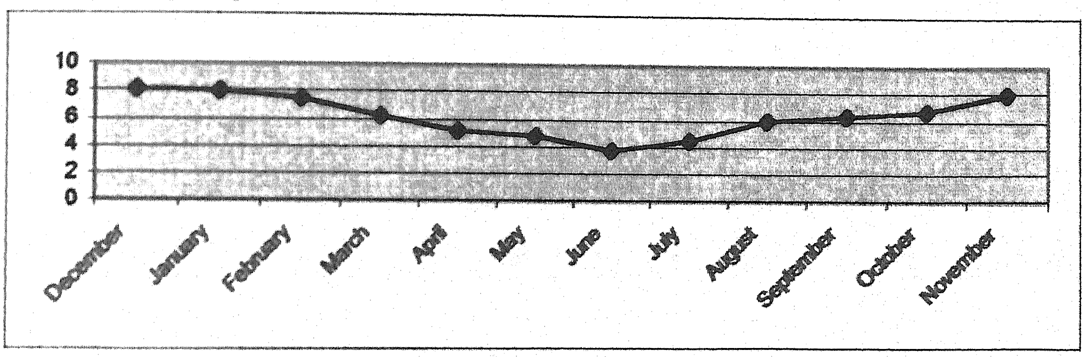


Fig No. 66

STATION - D

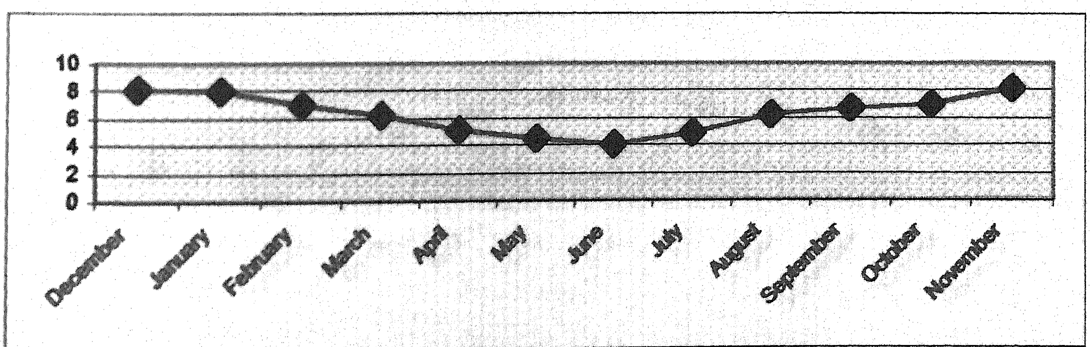


Fig No. 67

Period - 2001-2002

STATION - A

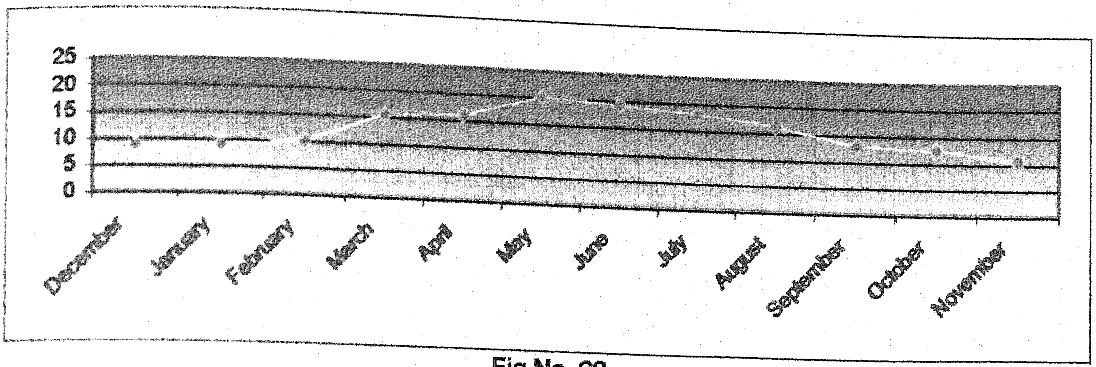


Fig No. 68

STATION - B

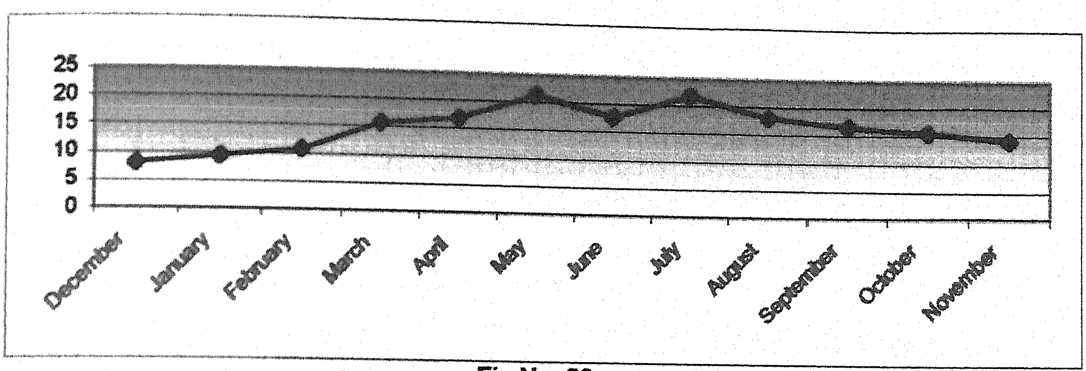


Fig No. 69

STATION - C

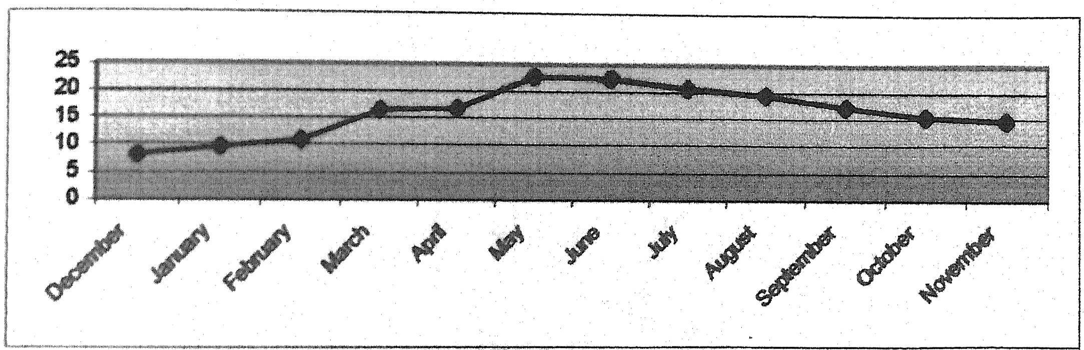


Fig No. 70

STATION - D

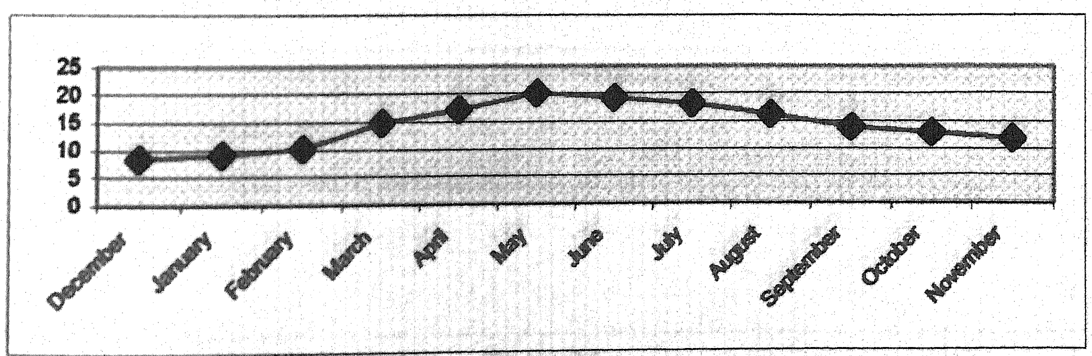


Fig No. 71

Carbon-di-oxide in ppm

Period - 2002-2003

Carbon-di-oxide in ppm

STATION - A

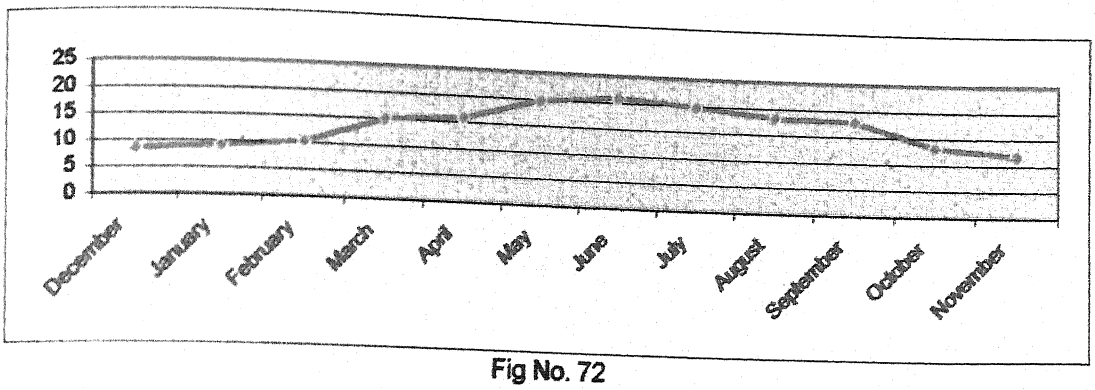


Fig No. 72

STATION - B

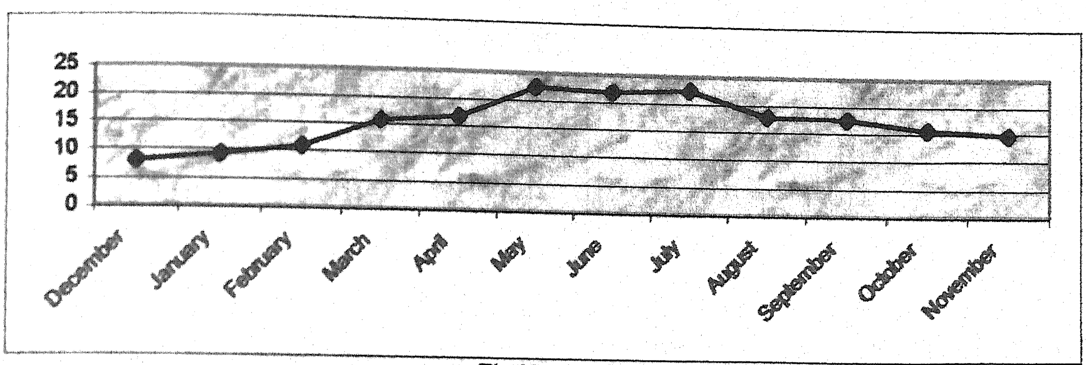


Fig No. 73

STATION - C

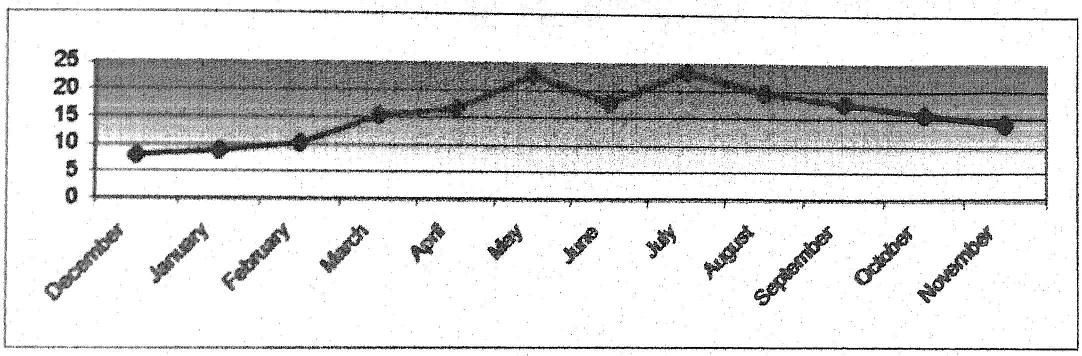


Fig No. 74

STATION - D

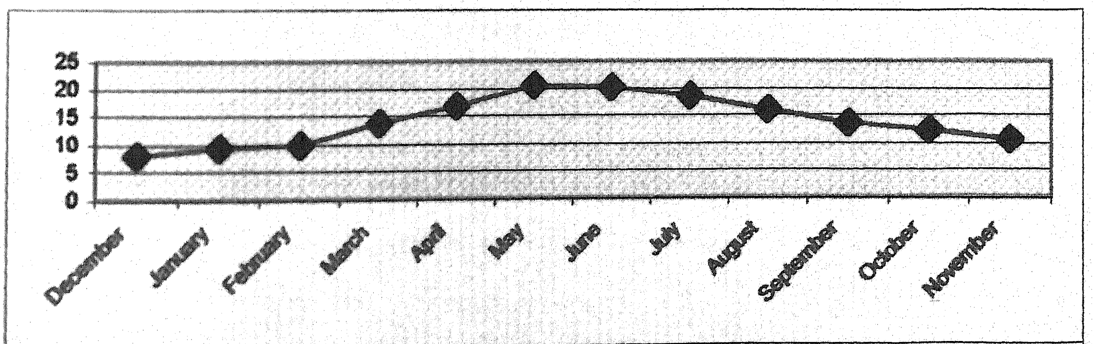


Fig No. 75

SUMMARY

SUMMARY

Water is the prime need of living beings, which is available from the natural resources in the form of Rivers, lakes, ponds, reservoirs, seas and even ground water. Relating to the fish productivity, the lentic water can be managed by the applying of some measures for better production. Hence, Keerat sagar at Mahoba (U.P.), which is the perennial water body was selected in this regard, which is still unexplored. So hydrobiology of this sagar was studied.

As regards hydrobiological studies a number of workers of foreign countries have reported in this field, whereas in India this work has not been performed sufficiently. Obiviously many lentic water bodies are still to be unexplored in this regard.

The contribution of various workers related to this field have been scanned which have been mentioned in the re'vie'w of literature. Their work was studied in concern of physical, chemical, biological and soil factors with particular emphasis for fish production, which is the primary need to solve the food problem as substitute of agriculture products.

Keerat sagar was studied hydrobiologically and various factors i.e.. Temperature, relative humidity, turbidity, colour, depth, photoperiod, water movements, rainfall, pH, dissolved oxygen, ammonical nitrogen, phosphate, chloride, carbon-di-oxide, carbonate, bicarbonate, total alkalinity, aquatic weeds, plankton (phyto and zooplankton) fish fauna and chemical condition of soil were taken in the present work.

Metereological data i.e. atmospheric temperature, photoperiod, relative humidity and rainfall were recorded for the period of Dec. 2001 upto and Nov. 2003.

During this period of two years study atmospheric temperature ranged from 14.6^{0}C to 32.5^{0}C. The maximum temperature in the month of June and minimum in January were recorded. The photoperiod was found to be maximum in month of June (15.30hrs.) and minimum in December (10.18hrs.) relative humidity was found maximum in August (81.16%) and minimum (16.17%) in the month of May. Rainfall was maximum in the month of August (248.32mm.) and minimum in December (1.3mm.) during the study period (from December, 2001 to November, 2003) . It was recorded in the different seasons. The atmospheric temperature showed positive relationship to photoperiod whereas relative humidity was also positively related to the rainfall. Relative humidity impacts negatively on atmospheric temperature. All the metereological conditions directly influence on the water characteristics of the sagar.

The physical factors related to water body are : water temperature, water movements, depth, colour, turbidity they were studied in Keerat sagar.

Water temperature was recorded to be maximum in the month of June (32.5^{0}C) and minimum in January (14.6^{0}C) during the study period. Water temperature is directly related to atmospheric temperature. The seasonal changes in water temperature affected the chemical and biological characteristics of the water.

Water movement of the water was affected by wind velocity. Maximum movement of water was found in summer season (May & June) and minimum in winter season (January and February) during both the years. Water movement is directly related to wind velocity, which adversely affects in fish catching.

Depth was recorded maximum in rainy season, while minimum in summer. The average depth of the Keerat sagar was (3.75metre) during the study period. Depth in directely related to the rainfall. It effects the fish production.

Colour of the sagar water was found to vary i.e. muddy, green and brownish. The muddy colour was noticed in monsoon period (July to August) due to rains which cause silting through runoff the water, while green to greenish in winter which was the indication of chlorophyceae in the sagar. This indicated more growth of phyto-plankton, further in summer brownish colour was observed which showed much production of Bacillriophyceae.

Turbidity maximum value was found in the month of August (69.20 N.T.U.) and minimum in December (14.02 N.T.U.). Turbidity increased in the rainy season and in summer season. Hence it is directly related to rainfall and wind velocity in respective seasons. This factor is negatively related to phytosynthetic activities, and is positively related to production of biota in water.

Chemical factors were analysed in the Keerat sagar according to APHA (1985). The factors were taken for study are : pH, carbonate, bicarbonate, total alkalinity, chloride, ammonical nitrogen, phosphate, dissolved oxygen and carbon-di-oxide. These were studied for the period of two years (December, 2001 to November, 2003).

The pH value ranged between 7.42 to 8.6 during the study period. The maximum value was (8.6) in march and minimum (7.4) in August. The water was found alkaline throughout the study with minor fluctuations during the period of investigation, which is favourable for the fish productivity. pH is directly related with total alkalinity.

The carbonates were found maximum in December (17.50ppm) and minimum in May (5.50ppm) and bicarbonates recorded maximum in the month of July (158.50ppm) and minimum (136.20ppm) in November. Total alkalinity was maximum in July (209.14ppm) and minimum in November (147.50ppm) in both

the years of study. Thus, the carbonates showed an inverse relationship with bicarbonates. A direct relationship was found in bicarbonates and free carbon-di-oxide. Total alkalinity directly affects the well being of fishes, because low values are biologically less productive than those with high values. Hence, the Keerat Sagar water is hard which help in production of biomass (Hutchinson, 1957).

The chloride value was found to be maximum (46.10ppm) in June and minimum (10.00ppm) in August during both the years. An inverse relationship between the chloride concentration and the water level was also found. Besides, the chloride contents showed direct relationship with phytoplankton and inverse relationship with zooplankton.

The ammonical nitrogen value was maximum (0.82ppm) in June and minimum (0.28ppm) in November during the study period. It first converts into nitrite and later in nitrate nitrogen. This factor is positively related with phosphate.

The phosphate value was maximum (0.73ppm) in June and minimum value (0.21ppm) in November during both the years. Phosphate is the limiting factor as its defficiency lowers the productivity of water. Phosphate is positively related with ammonical nitrogen.

The dissolved oxygen (DO) value was maximum (8.40ppm) in November and minimum (3.38ppm) in June during the study period. The DO value shows negative relationship with the water temperature. The dissolved oxygen is positively related with the photosynthetic activity which is perfromed by flora. An inverse relationship was found between dissolved oxygen and carbon-di-oxide. The zooplankton also showed negative relationship with dissolved oxygen, whereas direct relationship of dissolved oxygen with phytoplankton was observved. DO plays very

important role in physiology of biota, obviously it is positively related with the production of fishes.

The carbon-di-oxide value was maximum (23.60ppm) in May and minimum value (7.90ppm) in December during the study period. The carbonates and the photosynthetic activities showed inverse relationship with carbon-di-oxide concentration whereas the bicarbonates had direct relationship.

Regarding, biological characteristics of Keerat sagar the flora (micro & macro) and fauna (micro & macro) were studied which are : Aquatic weeds i.e.- submerged, free floating, marginal emergent, marginal and floating weeds phytoplankton, zooplankton and economically important fishes.

The aquatic weeds of the Keerat sagar were exomined monthly during both the years of study. These are :

<u>Trapha natans</u>, <u>Eichhornia crassipes</u>, <u>cyperus</u>, <u>corymbosus</u>, <u>Ipomea aquatica</u>, <u>Nelumbo spp</u>, <u>Potamogeton indicus</u>, <u>Nazas minor</u>, <u>spirudilla polyrhiza</u>, <u>polygonum glabrum</u>, <u>ceratophyllum demersum</u>, <u>Pistia spp</u>. <u>Vallisneria spiralis</u>, <u>Lemna paucicostata</u>, <u>Azolla spp</u>. They were noticed throughout the period of work.

The plankton was quite abundant in the sagar during summer month (June) and in winter months (October and November). Whereas, the lean period was recorded during monsoon period (July, August and September). The phytoplankton constituted the major partof the total plankton. However, the zooplankton were relatively sparse. The Chlorophyceae, Bacillariophyceae and Myxophyceae were the representative groups of phyto-plankton. The largest group was chlorophyceae second largest group was myxophyceae and then Bacillariophyceae. They impart colour to the water. The zooplankton were comprised of Rotifera, crustacea and

Protozoa. The green algae and rotifers dominated phytoplankton and zooplankton respectively. They are positively related with phosphate and ammonical nitrogen and diurnal fluctuation of zooplankton show positive relationship with photoperiod and temperature.

The economically important fishes were dragged out and studied during the study period Fishes are : Labeo rohita, Labeo calabasu, catla catla, cirrihinus mrigala, wallago attu, Heteropneustes fossilies, chanda nama, chanda ranga, mystus seenghala, clarius batrachus, Notopterus chitala, channa marulius. These fishes are of food value, but they are quite less in number which indicates that this sagar has not been managed scientifically for the proper fish production for which the measures are suggested inlast.

The soil of the sagar was analysed during both the years. Its various constituents which are leached in water directly affects the nature of water body as regards its productivity.

The soil pH value was maximum (8.6ppm) in December & January and minimum value (8.0ppm) in August. That is alkaline in nature which directly affects water and shows positive relationship. The alkaline nature of water and soil is suitable for fish productivity.

The soil phosphorus value was maximum (42.0ppm) in November & December and minimum value (10.15ppm) in April and May. Soil phosphorus promotes the growth of phytoplankton and aquatic weeds. Thus it shows positive relationship.

The soil nitrogen value was maximum (0.85ppm) in March, April & May and minimum value (0.20ppm) in July, August and September. Which is considerable

for fish production. Hence this factor shows direct relationship.

The soil potassium value was maximum (255ppm) in February, March and April and minimum value (50ppm) in August and September. This promotes the growth of aquatic weeds. Excessive growth of weeds adversely effects the fish productivity in the sagar. Hence negative relationship was observed.

Conclusion and Aim

On the basis of the present investigation the Keerat sagar can be used as an ideal fish farming with some scientific measures which are proposed here after giving its actual position. It is a perennial water body spread over a vast land enclosed partly by embankments, ingressed by Madan Sagar water provided with inlet and outlet. Water is alkaline high concentration of nutrients due to rich organic contents, thus, the water is properly manured. The plankton (phyto and zooplankton) were quite abundant which enable the water considerably productive.

But it has some drawbacks for which the scientific measures are being suggested so that its water conditions might be more suitable for sufficient production of fishes. As the fish prodctivity at present is poor inspite of some suitable water characteristics

As my main aim of study is to maintain the water body of this sagar properly for maximum production of fishes available for food. As regards this some scientific measures are being suggested which are :

(i) Regular supply of fresh water through inlet which should be provided with check gate for definite supply of water.

(ii) At outlet measurement gate should be fitted so that time to time excess water might be discharged in the adjoining canals. Besides it will be helpful in the removal of the foul water time to time. It will also be useful in circulation of the water.

(iii) The embankment should be made around the entire sagar so that a definite depth of sagar might be maintained.

(iv) Aquatic weeds specially Eichhornia spp. should be removed so that the water circulation as will as free movement of fishes might be possible.

(v) Wastes should be checked to avoid the pollution. So, the Keerat sagar can be used for an ideal fish farming by implementing the above suggested measures.

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